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OUR OCEAN RAILWAYS

OUR
OCEAN RAILWAYS

Or, The Rise, Progress, and Development of
OCEAN STEAM NAVIGATION

BY

A. FRASER-MACDONALD.

With Maps and Illustrations

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OUR OCEAN RAILWAYS.

CHAPTER I.

Introductory: Navigation and Maritime Discovery before and during the Fifteenth Century.

BEFORE the maritime achievements of Vasco da Gama, Columbus, and the other early Navigators, the vast and mysterious, because yet unexplored Atlantic was known as

THE SEA OF DARKNESS.

Among the ancients, for example, we find a friend of Ovid putting the following expression of dismay into the mouth of Germanicus as he entered that ocean:

> Quo ferrimur? ruit ipsa Orbemque relictum
> Ultima perpetuis Claudit tenebris.

The Arab Ibn Khaldûn, writing at the close of the fourteenth century, described the Atlantic as "a vast and boundless ocean into which ships did not dare to venture out of sight of land, for if even the sailors knew the direction of the winds they would not know whither they would carry them, and as there was no inhabited country beyond it, they would run great risk of being lost in mist and darkness." He further asserted that "the limit of the west was the Atlantic."

Such, concisely, was the extent of maritime and geographical knowledge five centuries ago respecting the trackless wilderness of waters which surrounded the known and inhabited parts of the globe. The mystery which, however, had thus since creation hidden one great portion of it from our race, was now to be removed in order that in its multiplication it might take fuller possession of that home which the great Creator had prepared for its occupation. Its various tribes and families were, in obedience to the Divine command, to subdue the earth, to have dominion over the fish of the sea and fowl of the air, and of every living thing that moveth on the earth. Provision had been made for their sustenance, for our first parents were told by Him that every seed upon all the earth, and every tree in which was the fruit of a tree yielding seed, was created and given them for meat! Now, in the fulness of the times of Divine Providence, the way was to be opened to immense continental storehouses of these resources, which, until they were needed, had been kept by it in reserve for mankind. The initiatory steps for the accomplishment of this great purpose were taken by Prince Henry of Portugal, who, on that account, was appropriately called "the Navigator."

Until his days the pathways of the human race had been the mountain, river, plain, and strait, or inland sea. To him the honour is due of having first conceived the notion of opening a road which, though replete with danger, was yet so full of promise. And here we may with national pride recall the interesting fact that this Prince who thus opened the way for the maritime explorations which have given Britain an empire on which the sun never sets, was the son of an English Royal lady, the daughter of John o' Gaunt—time-honoured Lancaster—and therefore the nephew of our own King Henry IV., and grandson of Edward III. of England.

In order to carry out his intentions relative to oceanic navigation, Prince Henry relinquished the ease and pleasures of Court life and took up his abode at Sagres—situated on a rocky point near Cape St. Vincent. As has been well said: "If in imagination we mark on the face of the ocean the tracks of navigators which led to the discovery of mighty continents, we shall find that all of them carry us back to the motive which induced him to take up his residence there."

It is important to note in this connection that the fifteenth century is generally regarded as the last of the so-called Dark Ages. The invention of printing in that which preceded it has been likened to opening the eyes of a blind man, for it let in so much light that all things began immediately to wear a new aspect. A medium of thought had been introduced. Men not only had food for reflection, through the information it supplied, but were provided with a channel of communicating their thoughts to each other. But the printing-press had not as yet given to the world at large the accumulated wisdom of the past when Prince Henry, after much study, had already traced out a pathway to India by an anticipated Cape of Good Hope. The compass then, although known, had not yet emboldened mariners to leave the coast for the open sea; nor had they charts to guide them along the perilous coasts of Africa, nor lighthouses along it to warn them off its dangerous points.

Prince Henry, however, diligently collected all the information supplied by Ptolemy, Hipparchus, Strabo, and other ancient geographers. He also studied mathematics and astronomy so far as they bore upon navigation, and by the offer of princely gifts he secured the co-operation of the boldest and most skilful navigators of the day.

The result of his labours was the reduction of geography and navigation to a system, and a vast improvement in the making of maps. It also brought the compass into such general use, rendering mariners so bold and venturous as to navigate their vessels on the gloomiest days and darkest nights. The extent of their discoveries naturally consequent on this induced greater hardihood of their enterprises.

Hitherto every bold headland and bold promontory had barred their progress. Cape Non, a few degrees south of the Straits of Gibraltar, formed the barrier of their progress in that direction, for they were deterred from doubling its rocky, storm-beaten point.

These early mariners had also imagined that the Equator was girdled by a torrid zone, the waters of which were so heated by a blazing sun that their waves beat boiling on its shores.

Now, however, Cape Bojadour was doubled, the tropics penetrated and divested of their imaginary terrors, the African coast explored from Cape Blanco to Cape de Verde, and the frontier of Europe advanced three hundred leagues by the discovery of the islands off the latter and those of the Azores.

But it was not until many years after Prince Henry's death that Vasco da Gama, following the track the Prince had traced, doubled the Cape of Good Hope, and, sailing along the coast of India, opened up to the West a commercial highway to the opulent regions of the East. He had, however, formed companies and associations, which, under the influence of the commercial zeal they excited, made them and other subsequent discoveries a matter of interest and competition. The new expeditions sent out from time to time from Lisbon, and others returning with accounts of new tracts explored and new kingdoms visited, added to this excitement, for every new discovery was magnified by imagination. For example, the barbarous tribes met with along the African coast were represented as powerful nations by those who had come into contact with them. Voyagers also brought back reports of the existence of other opulent countries beyond the regions they had visited.

The fame of these Portuguese discoveries and expeditions attracted to Lisbon many of the learned and of the inquisitive and adventurous from all parts of the world, and amongst them Christopher Columbus, who arrived there about the year A.D. 1470.

He soon after married the daughter of a lately-deceased Italian cavalier, Monis de Perestrello, who had been one of the most distinguished navigators under Prince Henry, and who had colonised the island of Porto Santo. Here the newly-married couple resided with the mother of the bride, who placed at the disposal of Columbus all the papers, charts, and journals of her late husband, and communicated to him all she knew about his voyages and expeditions. He thus became acquainted with the ocean routes of the Portuguese, and their geographical surmises and plans. Having become naturalised, he occasionally took part in their expeditions to the coast of Guinea. When on shore he supported his family by making maps and charts, which in those early days not only commanded high prices,* but ranked the man who made them among men of science, because of the knowledge and experience which such a work required.

Such associations and employments were naturally calculated to foster a train of thought favourable to nautical enterprise. Consequently, from comparing maps and charts, Columbus is credited with having become so impressed with the idea that much of the world still remained unknown, and was thus led to ponder on the means of exploring it.

---

* Americus Vespucius paid the equivalent of $555 for a map of sea and land made in 1439 at Mallorca.

Geography, at this period, was only emerging from the darkness which had enveloped it for ages. Ptolemy was its standard authority. The maps of the fifteenth century show a mixture of truth with error, in which facts handed down from antiquity, and others, the fruits of recent discovery, were mixed up with fables and extravagant conjectures. All this tended to increase the excitement which, as already stated, existed amongst the people of this eventful era.

Some of the rumours respecting unknown islands casually seen in the ocean, were fables fabricated to feed the prevailing popular humour. Others had their origin in the imaginations of voyagers, who saw land in the clouds that lay along the horizon, as many inexperienced ocean travellers now often do. The people of the Canary Islands, for example, affirmed that they saw a large island to their westward, which had lofty mountains and deep valleys. It was visible, they further asserted, in clear and cloudless days. So persuaded were they of its existence that, under permission obtained from the King of Portugal, they sent out expeditions to discover and take possession of it. Some regarded it as the island of Antilla referred to by Aristotle; others, that it was that to which the seven bishops banished from Spain by the Moors were guided miraculously. In the current belief it was recognised as the legendary island on which the Scottish priest St. Brandon had landed in the sixth century. It was, therefore, called after him, and laid down in maps of the ocean far to the west of the Canaries. The same honour was conferred on the fabulous island of Antilla. These erroneous maps and phantom islands gave rise at various times to the assertion that the New World had been known before the period of its alleged actual discovery.

Such, then, concisely, was the state of public thought with regard to the Atlantic before its western boundaries had been ascertained. Under its influence Columbus began to study anew the geographical authors he had read before. He also made himself acquainted with all that had been written by the ancients on the subject of geography, or discovered by the moderns. Although he regarded all the reported appearances of land in the west as merely illusions, and supported his views by many arguments, he noted them with curious care on his maps. His own voyages enabled him, however, to correct many of the current errors on the subject, and substantiate, at the same time, many of the other notions concurrent with them. It was thus he began to work out his grand project of discovery.

Dividing the earth, in its rotation of twenty-four hours of fifteen degrees each, and measuring from the City of Thinæ, in Asia, to the Canaries, he reckoned that there remained eight hours, or one-third of its circumference, as yet unknown. It became manifest, therefore, to him that, by pursuing a direct course from east to west, a navigator might arrive at the extremity of Asia and discover intervening lands.

This conviction was further strengthened by the statements of Aristotle, Seneca, and Pliny, that one might pass from Cadiz to the Indies in a few days; and that of Strabo, who observed that the ocean surrounds the earth, washing the east shores of India and the west coasts of Spain and Mauritania, so that it was easy to navigate from one shore to the other on the same parallel.

The narratives of Marco Polo and John Mandeville, who had visited parts of Asia far beyond the regions laid down by Ptolemy, also influenced him in this notion. Columbus inferred from them that a voyage to the west of no long duration would bring him to the shores of the extensive and rich islands described in them as lying adjacent to that continent.

Amongst the other sources of information which probably induced Columbus to start on his adventurous voyage was one undertaken in A.D. 1463, or nearly thirty years before it, of Ioão Vaz Corteral, in which he discovered Terra de Bacalhars, or the land of Codfish, that is, Newfoundland. Although uncertain of the weight which he may have attached to that discovery, we are safe in assuming that he knew of it.

The many pilots who were experienced in western voyages to the Azores and Madeira must have supplied Columbus with facts tending to deepen his conviction of an unknown land towards the west. Martin Vincent, pilot to the King of Portugal, for example, informed him that 450 leagues distant from Cape St. Vincent he had picked up a piece of wood at sea which was artistically carved, but not by an iron instrument. This wood, in their ignorance of the Gulf Stream, had, they supposed, been driven across the ocean from some as yet undiscovered islands beyond the Azores and Madeira. A similar piece of carved wood was subsequently found near the former islands, and the King of Portugal showed Columbus several large canes sent to him which were taken from the ocean in the same locality.

The first colonists of the Azores also reported that when the wind blew from the west, the sea often threw up on the shores of Graciosa and of Fayal pines of a foreign species. They also reported that two corpses had also come ashore at Flores, differing both in features and in physiognomy from Europeans. In this instance the people traced their arrival on their shores to what was subsequently recognised as the Gulf Stream, and which we know brings annually to the shores of the west and south of Ireland, and to those of the Hebrides and Norway, the seeds of tropical plants and the débris of the cargoes of ships wrecked in the West Indies.

We have thus rapidly sketched the leading incidents which marked the dawn of ocean navigation, and which eventually led to the dispersion of that mystery which had from the earliest ages hung over the Atlantic, and have connected them with the discovery of America with which Columbus is credited. That old world in which Henry of Portugal lived and wrought out his geographical conceptions, and that new one to the discovery of which he thus opened the way, have joined together to express at Chicago their joint admiration of the latter achievement.

It is right that such an expression should have been initiated by the descendants of that race of which this Prince was a Royal grandson, for the maritime explorations instituted by him, as has been rightly said, were "the anvil upon which the link was forged by which Europe has been connected with America." They have also another claim to a share in the honour of linking together these great continents which it will be interesting to notice, before referring to that supplied by steam navigation in our next chapter.

While availing himself of every source of information within his reach relative to the existence of a Western continent, Columbus, as already stated, studied attentively the works of such geographical authors as suggested a short route to India. He was especially fond of those written by Frenchmen. Amongst these was the "Imago Mundi," by D'Ailly, his own copy of which is now preserved in the Cathedral at Seville. In writing to Ferdinand and Isabella from Haiti, in A.D. 1498, he made a quotation from this work. This led a Gallic writer to claim that the discovery of America by the great Genoese was due to French teaching.

Unfortunately for this assertion, the work of D'Ailly was a mere compilation, and the passage quoted by Columbus was taken without acknowledgment by the former from the "Opus Majus" of our own Roger Bacon, published in A.D. 1367!

Then again, although Columbus saw land off the coast of America on October 12th, 1492, it is well known that Sebastian Cabot discovered that of North America a year before the former landed on the *terra firma* of South America.

The ship *Matthew*, in which the latter sailed from Bristol, and in which he explored the coast of the former from Hudson's Bay to the southern part of Virginia, was manned by British sailors.

But before Columbus had decided upon undertaking his first adventurous voyage, it is well known that he had often visited Bristol in his capacity of pilot, a designation equivalent to our captain or sailing-master. That port was then much frequented by whalemen, who, in the pursuit of their vocation, had often been up the North Seas, and who had brought back with them many of the old Norse traditions. During these voyages they often touched at Reif Kjavik, the capital of Iceland, in whose well-sheltered bay they were accustomed to take refuge from the heavy storms so frequent in the Atlantic. On such occasions they probably heard the Icelanders tell of a vast continent in the West, which had been discovered and colonised by their renowned ancestors—the wild, seafaring Vikings.

Such stories would naturally become one of the yarns which, on their return, these Bristol whalemen would delight in "spinning," either at their own firesides or in the taverns of the port.

Columbus would naturally listen with deep interest to such stories, and, after turning them over in his own mind, would desire further information about the land in the West to which they referred. Hence his voyage to Iceland in order to secure this knowledge. Icelandic tradition not only states that he did make a voyage there in A.D. 1477, but Icelanders at this day point out with pride the very spot where he landed on the occasion of his visit.

Their "Sagas," or historical narratives, form a valuable and comparatively authentic record of the social and political life of mediæval Northern Europe. They tell us, for example, that Greenland was discovered by Icelanders in A.D. 982, and the continent of America in A.D. 1000. We may, therefore, fairly conclude that on the occasion of the visit of Columbus referred to, the Eyrbyggja Saga, or Thorfinn's Saga, containing the history of these discoveries, may have been communicated to him by the Icelandic farmer who owned them, and that they emboldened him subsequently to make his proposals, first to the Court of Genoa and then to that of Spain, for an exploring voyage to the westward.

It is interesting in this connection to mention that the most richly illuminated MS. in the Royal Library at Copenhagen—the "Codex Flateyensis"—contains the history of "Eric the Red" and of his son "Leif the Happy." It was written by two monks at Flatoë, in Iceland, in two volumes, on fine parchment, between A.D. 1370 and A.D. 1380. The first volume contains their history, which occupies about half-a-dozen pages.

It states that both father and son left Iceland in A.D. 982, and, sailing west, discovered Greenland. Leif returned to Iceland, and went thence to Norway, where he was persuaded by King Olaf Trygevsen to embrace Christianity and go back as its missionary to this newly discovered country. When on his voyage there he was driven by adverse winds to the coast of America, as far south, it is believed, as Massachusetts, designated in the Codex *Vinland*, or "Wineland," probably because Leif and his companions had found wild grapes growing in abundance there. In recognition of their maritime exploits, "Eric the Red" has a statue erected to his honour at New York, and Leif has been similarly honoured, conjointly by Americans and Norwegians, at Boston.

That these Icelandic or other Norse sea-rovers sailed along the American coast even further south than Massachusetts, seems probable from a tradition current amongst the Indians of Honduras and Yucatan. It states that at a period of three or four centuries before Columbus landed on the American continent, a race of strange people, having blue eyes and fair hair, had visited their country.

M. Napoleon Ney, President of the Society of Commercial Geography, positively asserts that the coast of North America was visited by Europeans as early as A.D. 1000. After visiting Vinland their ships entered Chesapeake Bay and descended as far as Florida, where the Normans established themselves till the epoch at which Jean de Bettencourt took possession of the Canary Islands in the name of King Charles VII.

The Smithsonian Institute at Washington possesses an important collection of documents concerning pre-Columbian America, confirming the preceding statements, but which, for want of space, cannot here be referred to in detail. Amongst them is a facsimile of "Dighton Writing Rock," known since 1860. The inscription is in Runic characters accompanied with cryptographic signs and drawings, and relates to the adventures of the Scandinavians in Vinland. It states that 131 men of the North occupied that country (Vinland) with Thorfinn. Another and more important inscription is that of "Arrow Head," three miles from the falls of the Potomac

River, and visited by M. Ney, and which, translated into English, runs as follows:

"Here lies Syasi, the fair one of western Iceland, the widow of Koldr, sister of Thorg by her father. Aged 25 years. God be merciful to her."

In the tomb were found three teeth, various toilet articles in bronze, two fragments of a necklace, and two coins of the Lower Empire.

The presence of coins here is accounted for by the fact that men of the North—Danes, Norwegians, and Swedes—were sought after to recruit the Guards of the Emperors of Constantinople.

What renders the inscription on the bank of the Potomac so particularly interesting, is the document discovered in Iceland in 1863, near the Church of Skalholt, dated A.D. 1117, and hence known as the Skalholt Saga, which relates the death of Syasi, and very clearly describes the position of her tomb.

The facts we have thus stated, with others known to many of our readers, and to which it is generally understood that attention will be called at the Chicago Exhibition, show that Icelandic and Norse sea-rovers in their dragon-prowed barks had, long before the Genoese navigator sailed over the western ocean, discovered the American continent, and formed settlements on its coast. But, nevertheless, to Christopher Columbus and his followers belongs the honour of making Europe practically acquainted with the New World. However indirect our share in this early development of ocean navigation, no one can deny that, as a nation and a race, we have long taken the lead in bringing it to its present condition. In fact, the world owes to us, as the following pages will fully indicate, not only its locomotion over land by steam, but also over the ocean.

CHAPTER II.

The growing demand in the Sixteenth Century for a power other than the "fickle wind" or "labouring oar" in propelling vessels, how responded to early in the Nineteenth Century by the introduction of steam.

"AND first of all, by the figuration of Arte itselfe, there may be made instruments of navigation, as large as ships, to brook the sea, onely with one man to steere them, which shall sayle more swiftly than if they were full of men."

Strange as it may seem to us in our days, thus wrote Roger Bacon at the end of the sixteenth century. We readily infer from the terms in which he expresses this opinion, the mental process by which it was arrived at. Having in view the progress which navigation had already made, he evidently had concluded that the human genius which had brought it so far in advance of what it had been in earlier times would eventually lead it up to the results he thus anticipated. He may also have had some conception, however indefinite, of a means or power other than wind and oars, by which vessels might be moved more easily and certainly than by either of these forces; which were only useful, as appeared to him, so long as there were men to pull the latter, and sufficient of the former and from the right direction to fill the sails of a vessel. Some propelling power more reliable than either was, in fact, generally sought after. Many of the suggestions made to meet this growing desire were, it may further be supposed, known to Roger Bacon when he wrote this prediction, evidently based on the firm conviction that it would eventually be found.

For example, we find one William Bourne, in A.D. 1578, thus suggesting in a book wheels as a motor for vessels instead of oars: "And furthermore, you may make a boat to goe without oare or sayle by placing a certain number of wheeles on the outside of the boate, in that sorte, that the armes of the wheeles may goe into the water, and so turning the wheeles by some provision, and so the wheeles shall make the boate goe."

Even at an earlier period than that in which this suggestion was made, wheels were looked upon as a useful motor for vessels. For example, one Parcerrollus of Padua states that he had seen an ancient bas-relief, representing a boat being propelled by three pairs of wheels turned by three pairs of oxen. They had, he further stated, boards a palm breadth projecting from their arms.

Whatever may have suggested Bacon's prophetic hope as to the future of navigation, its history, subsequent to his time, shows an increasing desire to secure an entire independence of the fickle wind and labouring oar. His forecast and his desire have been so far verified by the successful introduction of steam as a propelling power, that now, "by the figuration of Arte itselfe," vessels are being constructed, not only large enough "to brooke any sea," but also to go so swiftly as to have covered under six days the 3,288 miles between Queenstown and New York. The vessels of the lines of steamships which have accomplished this wonderful feat form the last link in a long chain of persevering and successful experiments, made to overcome the physical obstacles which, three centuries ago, confronted human progress and development by the restraints imposed upon the intercourse of the race by the oceans which separated its peoples and nations.

Any narrative intended concisely to review these efforts and experiments cannot but be in itself interesting, but may also enhance the enjoyment of their results by those who go down to the sea in our modern ocean palaces.

Although in the Middle Ages the art of navigation made rapid advances, it was not until the fourteenth century that the comparatively diminutive war galleys of ancient times began to be superseded by larger vessels, chiefly propelled by sails.

The improvements made in navigation from this period were consequent upon several important events and circumstances.

There was first the introduction of the mariner's compass, and then the application of astronomy to nautical pursuits. These at once freed the mariner from his previous dependence on coast lines and the stars as his guide. By the aid of these auxiliaries he now ventured to brave the unknown perils and mysteries of the trackless ocean. Brought into contact with unknown obstacles to navigation, he was thus encouraged to meet and eventually overcome them by persevering and eventually successful experiments.

There must also be taken into account in this connection that renewed activity of mind, brought about by the events of the fifteenth and sixteenth centuries, the introduction of the printing-press and the consequent advancement in the arts and sciences. All these influences combined resulted in the increase of commerce and the spread of civilisation.

In fine, in the language of the ancient prophet, many began to run to and fro, and thereby knowledge was increased.

Considerable attention was therefore given towards the improvement of water inter-communication. The results, however, from our standpoint were not very striking, as we may understand from the following summary of the nautical improvements up to his day by Sir Walter Raleigh, who, early in the seventeenth century, thus referred to them:

"Whoever was the inventor of ships, every age has added somewhat to them, and in my time they have been greatly bettered. It is not long since striking topmasts has been devised, together with chain pumps, which taketh up as much water as the old one. We have now studding-sails, and the weighing of the anchor with the capstan, moreover we have fallen into consideration of the length of cables, and by it we resist the malice of the greatest winds; for it is true that the length of the cable is the life of the ship!"

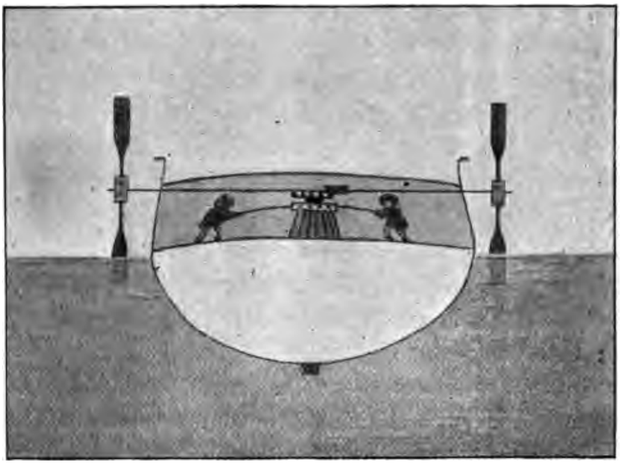
There was still, however, a more reliable motive power desired than was as yet known to navigators. Many occupied themselves in endeavouring to supply such a power.

Coming down to the close of the sixteenth century, for example, we find Thomas Savery, captain of a Cornish mine, suggesting a method by which wheels could be turned so as to propel vessels, in a little work with the following pretentious title:

"Navigation improved—or the art of Rowing Ships of all Rates in Calms with a more Swift and Steady motion than oars can, also a description of the Engine that performs it, etc. 'Magna est Veritas et prævalebit!'"

The engine to which he refers was simply a shaft across a vessel, with four broad oars inserted in each of its extremities and at right angles with it. This shaft was made to rotate by cog-wheels near its centre, connected with others attached to a capstan on a lower deck, turned with handspikes by sailors, as seen in our woodcut reduced from that in his book.

In these days when steam-engines are constructed to propel vessels nearly as large as Noah's Ark at the rate of over twenty knots an hour, we may smile at the great ado which Savery makes of his invention, when he tells us that it had cost him many years' labour and racking of his brains " to find out that which a great many have spent years in vain in the pursuit thereof." Still his effort, feeble as it appears to us, was one of the links in that chain of events which eventually led to the discovery of an easier and better motor for vessels than was then in use.



The paddle-wheel was a natural and right substitute for the oar, but there was still wanting an efficient power to move it. Unsuccessful as Savery was in his suggestion, we find his name early connected with an important incident which primarily led to the adoption of steam as that power. Early in 1698 he took out letters patent for a steam-engine for the purpose of draining mines. Though very simple in its construction, it indicated great progress in the direction of using steam instead of animal or manual power.

Several engines were erected on Savery's principle, but the introduction of Newcomen's improved engine in 1705 caused its abandonment.

The first suggestion we have on record towards the application of this new power to navigation was made by Jonathan Hull in 1736, who took out letters patent on December 31st of that year for his invention of "a machine for carrying ships and vessels out of or into any harbour or river against wind or tide, or in a calm, which may be of great service to our Royal Navy and merchant ships, etc."

Twelve facsimile copies of Jonathan Hull's description of his proposed steamboat were published by the Patent Office, one of which may be seen in the King's Library of the British Museum.

His plan was to move paddle-wheels, placed over the stern of a boat, by a steam-engine. The reciprocatory motion of the latter was arranged to be converted into the desired rotatory motion of the paddle-wheel by an ingenious but intricate system of bands and straps.

The engine was not placed, as nowadays, in the vessel to be moved, but in another by which it was to be towed. Although nothing came directly out of Jonathan Hull's suggestion, it affords an interesting illustration of the progress which had been made in his day towards the present state of steam navigation.

Another forward and important step was taken in 1778 in this direction by Dr. James Watt, who then obtained a patent for methods of lessening the consumption of steam and consequently of fuel in steam-engines. Hitherto cold water had been injected into the cylinder at every movement of the piston, thus cooling it. His improvement consisted in condensing the steam in a separate box, now commonly known as the condenser. This was the most important improvement which had up to that period been made in the steam-engine, and one which laid the foundation of its future success. But so far as its fitness for propelling vessels was concerned, a simpler method than that proposed by Jonathan Hull had yet to be contrived of converting the reciprocatory motion of the piston into the rotatory motion of the shaft.

The crank, so simple to us now, was then an unsolved mystery. In 1781 it was, however, patented by one Steed. There is strong proof that he had taken his idea from a pattern of a crank lying in Boulton & Watt's yard some time before the date of his patent. Be this as it may, the steam-engine was by its introduction rendered sufficiently perfect for its application to the propulsion of vessels, and was soon afterwards used for that purpose.

The earliest record we have of this was in August, 1791, when the United States Government issued four patents for steamboats. One of them was to John Fitch, who in 1793 propelled a boat on the Delaware River with paddles driven by steam. Although his experiment did not raise any public interest in his project, in a letter he declared to a friend : "This, sir, whether I bring it to perfection or not, will be the mode of crossing the Atlantic in time, for packets and armed vessels."

John Stevenson, another of the patentees, embraced in his experiments both the paddle-wheel and the screw which he reduced to practice. In 1804 he propelled his boat driven by twin screws across the Hudson River at a speed of six miles an hour. In conjunction with his son he built the *Phœnix* in 1808, and sent her round by sea from New York to Philadelphia, navigating the Atlantic from Sandy Hook to Cape May. Scott Russell regarded him from this event as the pioneer of steam navigation in the open seas.

To Scotland, however, belongs, as the following facts satisfactorily show, the chief honour of the invention of steamboats as a means of water transport.

In 1801–2 Mr. Patrick Miller, an Edinburgh banker, constructed a double boat with a paddle-wheel to be turned by a man. Subsequently he had a larger one made.

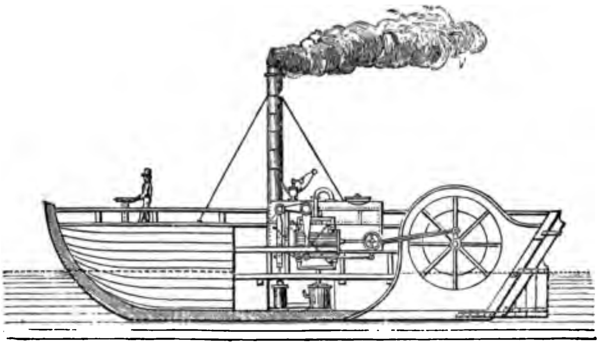
It was now suggested by Mr. Taylor, a tutor in Mr. Miller's family, that the man working the paddle-wheel should be replaced by a steam-engine. This suggestion was adopted, and William Symington, a mining engineer, and an old schoolmate of the Edinburgh banker, was employed to construct it. The engine of this first steamboat, now in the Anderson Museum at Glasgow, was of one horse-power, and propelled her at the rate of five miles an hour on a lake in the vicinity of Mr. Miller's house, near Dalswinton, in Dumfriesshire. It was a double boat, like the *Calais-Douvre*, with the engine on one side and the boiler on the other, and the paddle-wheel between the two hulls.

Encouraged by the results of his experiments, Mr. Miller bought a canal boat, used on the Firth of Forth and Clyde Canal, and had it fitted with a twelve horse-power steam-engine, made by the Carron Iron Company, after a design by Symington. The paddle-wheel was placed over the stern and connected with the engine by a rod and crank. This boat carried a large load on the canal at the rate of seven miles an hour.

In 1801–2 Lord Dundas, then governor of the company owning the canal, anxious that it should profit by the new invention, had a vessel constructed by Symington with an engine and paddle-wheels. Great astonishment was excited on its trial by its towing two loaded sloops of seventy tons each through the long reach between Lock 26 and Port

Dundas, nineteen and a half miles, in six hours, against a strong wind. This was by far the most successful of all the previous attempts at steam navigation.

This vessel, of which we give a longitudinal section, had a stern paddle-wheel driven by a direct-acting horizontal engine, with a cylinder twenty-two inches in diameter and four-feet stroke, which turned the paddle-wheel by means of a crank. When running free she travelled at the rate of six miles an hour.



Longitudinal Section of the *Charlotte Dundas.*

The proprietors were, however, so afraid that the undulations of the water by the paddle-wheels would injure the banks of their canal, that the *Charlotte Dundas*, as his lordship's steamer was called, was laid up in a creek near Rainsford Bridge, where she was an object of great curiosity for many years.

No practical results followed these early and valuable experiments, beyond deepening the impression on the minds of a few that steam-power might be made available for propelling vessels. Generally, however, the project was met by a similar incredulity and prejudice to that manifested twenty years later against steam locomotion by land. Even James Watt, when applied to in 1801 by Henry Bell, the father of steam navigation, for advice in regard to "a portable engine that would stand upon its own base, to be used in propelling vessels," replied by the following question:

"How many noblemen, gentlemen, and engineers have puzzled their brains and spent thousands, and none of all these, nor yourself have been able to bring the power of steam to a successful issue?"

Many also then looked upon the attempt as sinful, because it was an insult to Divine Providence to force a vessel against wind and tide! Nothing daunted, however, by these things, Henry Bell persevered in his attempts to give effect to his own firm convictions on the subject.

It is interesting to remember how many great discoveries have had their origin in trivial matters, as, for example, the discovery of the law of gravitation by Newton from his reasoning about the falling of an apple. Bell naïvely tells that his first impressions relative to the feasibility of applying steam-power to transmarine purposes were originated by a small rigged sloop, given to him when a boy. In sailing his mimic craft, when the current would drive it in a direction contrary to that in which he desired it to go, and the winds were either adverse or wanting, he reflected on the possible uses of steam to counteract these opposing forces.

In 1798 Mr. Bell turned his whole attention to his grand object, the steamboat. In the spring of 1800 he placed a boiler and engine of four horse-power, with machinery for a pair of paddle-wheels, in a pleasure boat lent to him for the experiment by a friend. So successful were the results that he submitted plans to Mr. Watt for an improved marine engine, with the disappointing results already stated. Left thus entirely to the resources of his own genius, he bravely faced and overcame the difficulties which beset his project.

In 1800 Mr. Bell submitted a memorial to the Lords of the Admiralty, calling their attention "to the practicability and utility of steam as a marine propelling power against winds and tides, and every obstruction in rivers and seas where there was a depth of water." My lords, however, informed him in reply, that, after a careful consideration of his proposition, they had come to the conclusion that it would be of no value in promoting transmarine navigation!

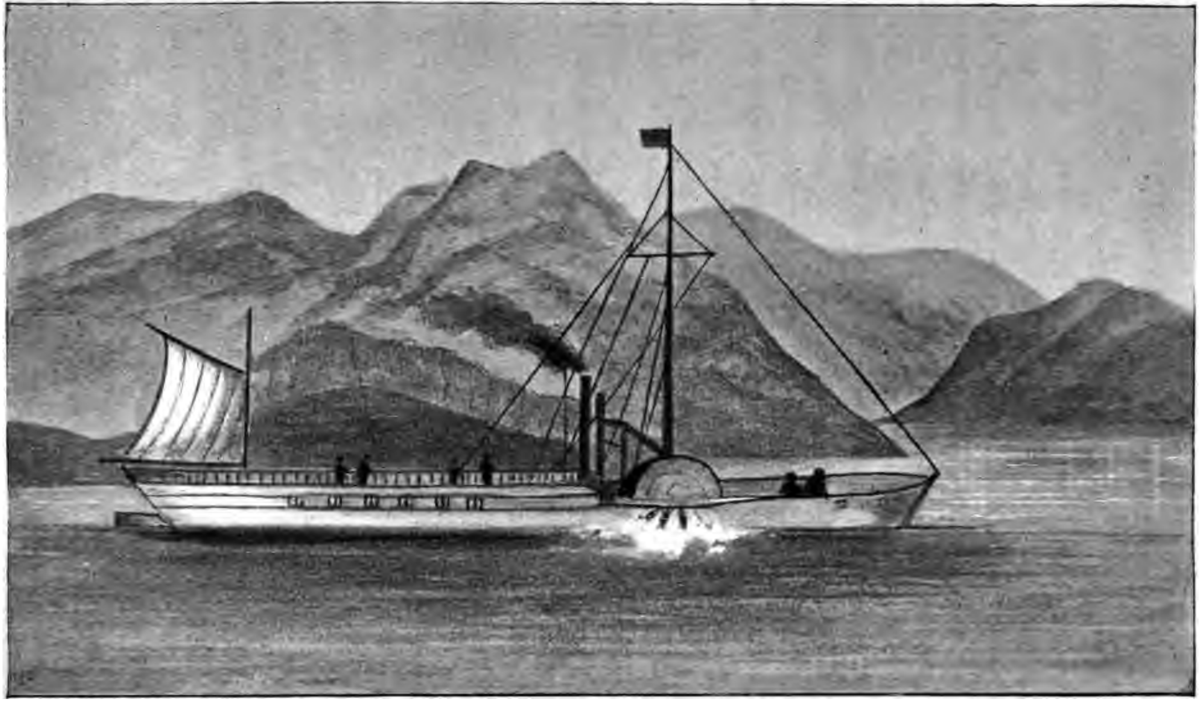
In nowise discouraged by this repulse, Mr. Bell made a second application to "My Lords" to be heard, but was informed by them that they had no faith in steam navigation. Our gallant Nelson was present at the meeting of the Board at which Mr. Bell's proposition was discussed, and recognising the mighty power steam would supply in the movements of ships of war, rose during the debate and said:

"My Lords and Gentlemen, if you do not adopt Mr. Bell's scheme other nations will, and in the end vex every vein of this empire!"

Failing to secure the support of his own country, Mr. Bell then sent copies of his prospectus on Steam Navigation to the Governments of Europe. He also sent one to that of the United States of America, and some years before Robert Fulton started his first steamer on the Hudson River!

The claim to the honour of the invention of steamboats between Bell and Fulton is satisfactorily disposed of in the following extract from a letter by the former replying to an inquiry on the subject, and dated March 1st, 1824:

"The father of the late Robert Fulton, the American engineer, was a native of Ayrshire who went to America, where his son showed an early inclination for engineering.



Fulton's Steamboat *Clermont* passing the Highlands, Hudson River, 1807.

He came at different times to this country and stopped with me for some time. Mr. Fulton published a treatise in London, in 1804, on 'Canal Declining Railways.' On his way to France that year he called on me, and also when he returned. He was then employed by the American Government to come to England and take drawings of our cotton and other machinery, etc. . . . When I wrote to the American Government on the great importance of steam navigation, and its admirable adaptation to their noble rivers, *they appointed Mr. Fulton to correspond with me. From this matter-of-fact statement you see the Americans got their first insight of this system of navigation* from your humble servant."

This letter also gives the true history of the *Robert Fulton* steamboat, *the engines of which*, at the suggestion of the writer, were built by Messrs. Boulton & Watt, of Soho, Birmingham. They were eighteen horse-power, with a twenty-four-inch cylinder and four-feet stroke.

In 1807 Mr. Fulton started his first passenger steamer on the Hudson River, naming her the *Clermont*, of which we give a woodcut, representing her steaming through the Narrows. Her dimensions were: length, 130 feet; beam, 16½ feet; depth, 17 feet. Fulton's first patent from the United States Government for the invention of steamboats was dated February, 1809.

The people of Albany, to which the *Clermont* sailed from New York, described the vessel as "a monster moving on the waters, defying winds and tides, and breathing flame and smoke."

It is also recorded that some farmers of Dutch descent, living on the banks of the Hudson, when they saw her passing up the river after dark, were so frightened at the noise made by her paddle-wheels and by the stream of sparks from her wood fires issuing from her funnel, that they fled with their families to the adjacent woods, under the impression that the *Tyfel* was coming up the river!

Canada was not far behind in the introduction of steamboats on her inland waters, for the steamer *Accommodation* was placed on the St. Lawrence in 1809, and the *Car of Commerce* in 1813. To the best of the author's recollection this was due to the enterprise of an English brewer, the late John Molson, who established a foundry at Montreal, where the steamers on the St. Lawrence were supplied with their machinery, and where subsequently, as will be noticed, the engines of the first steamship to cross the Atlantic, made by Boulton & Watt, were fitted up in her.

In 1817 two other steamers were placed on the St. Lawrence, namely, the *Quebec*, of 100 tons burden and 100 indicated horse-power, the engines for which were supplied by Messrs. Maudslay & Sons; and also the *Lauzon*, ferry steamboat, 150 tons measurement and 50 horse-power.

The engines of these early steamers were, as compared with those of the present day, curious pieces of machinery. The author, writing from his boyhood's impression of them, remembers some of those on the St. Lawrence, as late as 1832, being worked over the eccentric by a fly-wheel, and others being provided with numerous springs and belts.

Almost any stoker can now put a steam-engine out of gear, and either start or reverse it; but it was not so in these original days of steamboating. The father of the author often related in his hearing the following amusing incident in this connection. It occurred on the *Car of Commerce*, which began running between Montreal and Quebec, as stated, in 1813. A Scotch engineer had to be imported with the engine to work it—so novel and mysterious was its complicated machinery in the opinion of the natives.

On one occasion, when off the latter port, Sandy was discovered to be missing, and as no one else was competent or dared to try and stop the engine, the steamer had to be navigated up and down the river until he could be found. He had stowed himself away in a quiet corner for a nap, and when awakened and scolded for the inconvenience he had caused, testily replied:

"If ye had pit the fires oot she'd a' stoppit hersel'."

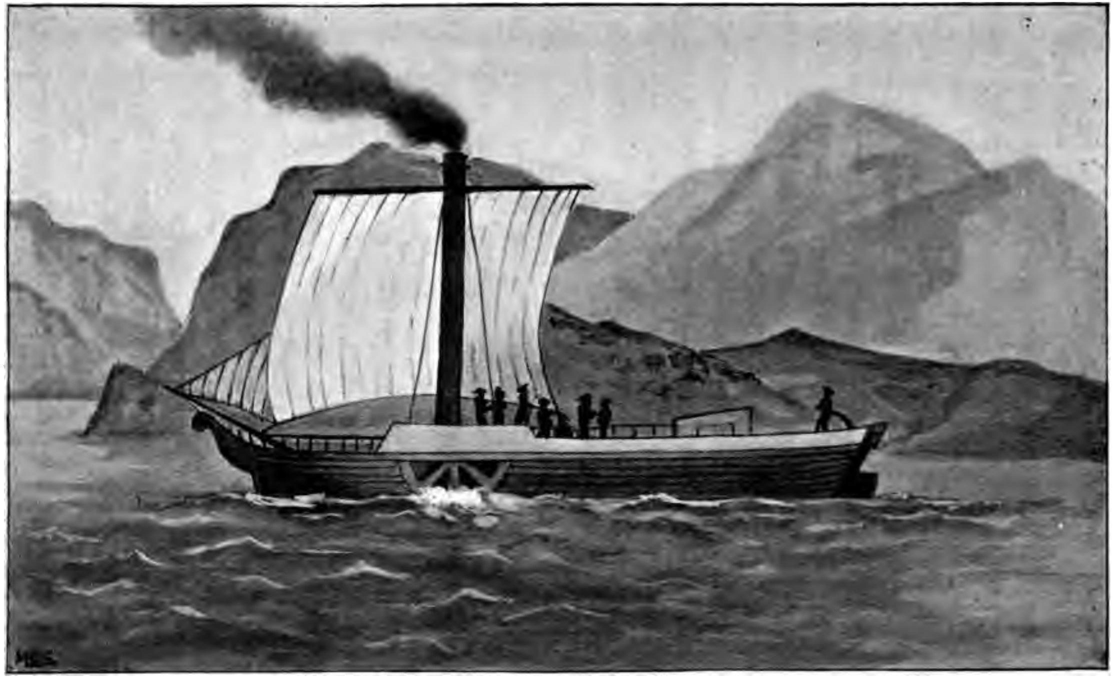
But to return to Scotland. The first regular steamer was placed on the Clyde by Henry Bell, in 1812, and was designed to carry passengers between his baths at Helensburgh, and Glasgow. She was called the *Comet*, and her dimensions were: length, 40 feet; breadth, 10½ feet. Her engines were four horse-power, driving two paddle-wheels of four boards each, in shape like malt-shovels. Her speed was about eight miles an hour.

By 1818 there were six steamers plying on the Clyde between Greenock and Glasgow, two of which carried goods as well as passengers. Larger boats were shortly afterwards built, one of which had a keel of 100 feet, and 17 feet beam, and an engine of 24 horse-power.

The mail-coach between Glasgow and Greenock had now met a formidable competitor in these steamers. It was allowed three hours and a half in which to make its journey, but by an extra effort this was reduced one hour. Still a decided preference was given to the steamboats on account of their cheapness and facility.

These steamers naturally excited great interest, and we have the following graphic description of them by Daniells, in his "Voyage Round Great Britain," published in 1818:

"In proceeding from Greenock to Dumbarton, a conveyance offered itself which forms a very striking peculiarity



Henry Bell's Steamboat *Comet* on the Clyde, 1812.

in the navigation of the Clyde. This was the steamboat, of which a sufficient number have been established to maintain a constant intercourse between Glasgow and Greenock. They can depart during any period of the tide, and in all winds, and perform the journey generally in 3 hours. . . ."

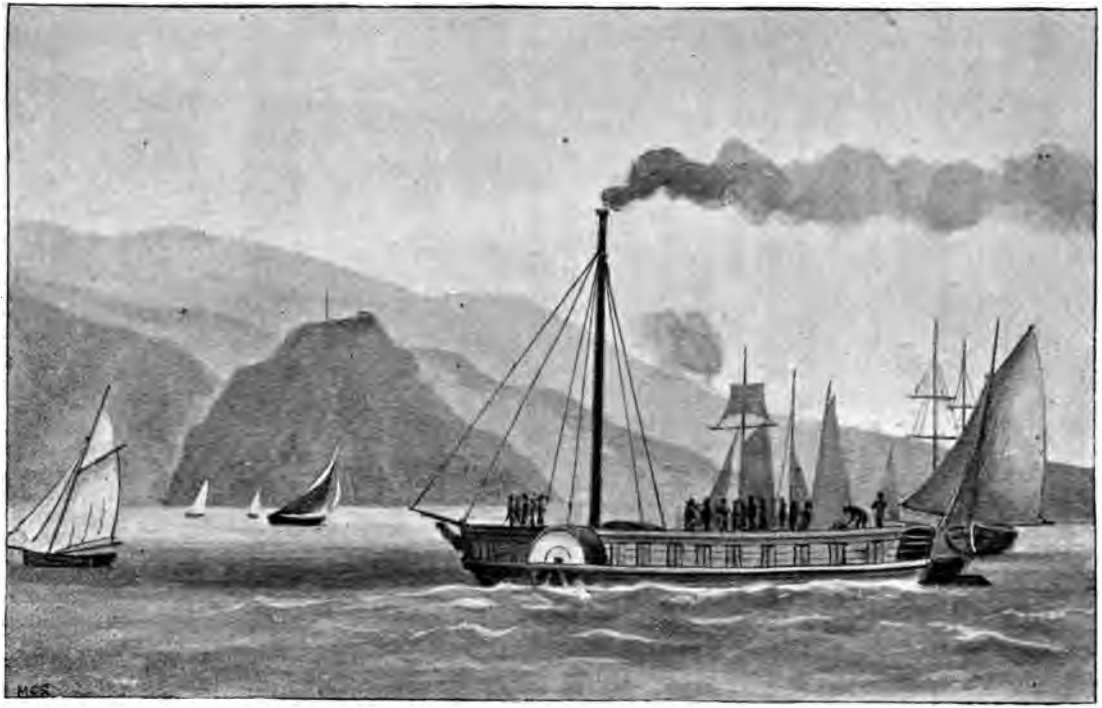
Referring to his illustration of them, Daniells continues:

"It is observable that the smoke of the engine is carried off by a tall cast iron chimney, bearing the semblance of a mast, and sometimes serving as a substitute for one, when the state of the wind will allow the sail to be hoisted on it with advantage. The stream of smoke from the orifice generally takes a horizontal direction in consequence of the movement of the vessel, forming a pendant of extraordinary length and of a very singular appearance. By this signal the people can distinguish the steamboats at a very great distance."

After a description of the cabins of the steamers, which were furnished, he tells us, with "draught-boards, and backgammon tables, and other implements of pastime, and with a library of that description of books called light reading," he adds:

"The steamboat takes in and lands passengers at Dumbarton and Port Glasgow, and the mechanism of her motion is such as to allow her to touch at these places with the least possible delay, and to lie-to or resume her course with equal promptitude. The rate of moving is delightfully uniform and rapid; and it is particularly amusing to observe with what ease she will outstrip a vessel though under full sail."

The first steamboat placed on the Thames made her trip on January 23rd, 1815. It was announced by a placard, which stated that the *Margery*—for that was her name—would start precisely at ten o'clock a.m. from Wapping Old Stairs, near London Dock, returning from Gravesend at the



" A very striking peculiarity in the navigation of the Clyde."—DANIELLS, 1818.

same hour next morning. It further stated that: "The said Packet having superb accommodations, passengers and their luggage will be conveyed to and fro with more certain speed and safety than by any other conveyance by land and water and on reasonable terms." The *Margery* was only 70 tons burthen, and her engines were but 14 horse-power, and yet her introduction to the public was made in such grandiloquent terms. Gravesend, also, three-quarters of a century ago, seems by the announcement to have been regarded as far off London as, say, Boulogne or Calais are nowadays. She was followed the same year by the *Richmond*, 50 tons burden, and fitted with engines of 17 indicated horse-power, made by Messrs. Maudslay, Sons, & Field, of London, and the first engine made by them for propelling vessels by steam. She ran between London and Richmond. In 1816 the steamer *Regent*, of 112 tons burden, and with an engine of 42 horse-power, built by the same firm, was placed on the route between London and Margate.

The steamer *Thames*, a larger vessel, was soon afterwards put on this Gravesend route, and made a trip each way daily. The fare on Sundays was three shillings; and on week days, saloon three shillings, and fore cabin two shillings. The placard announcing all this stated that "Ladies accompanied by gentlemen in large parties of pleasure *were free*, except on Sundays."

The refreshments provided on the *Thames* were tea, bottled porter, etc., and the public were informed that "Persons bringing their own provisions will be assisted with boiling water, provided in readiness on board."

This very primitive kind of arrangement was, it must be remembered, a very great improvement on the old Thames

Tilt-boat conveyance, which, not having boilers, could not offer to keep its passengers in hot water!

These first steamers on the Thames had often to be laid up for repairs to their machinery, sometimes for three weeks together.

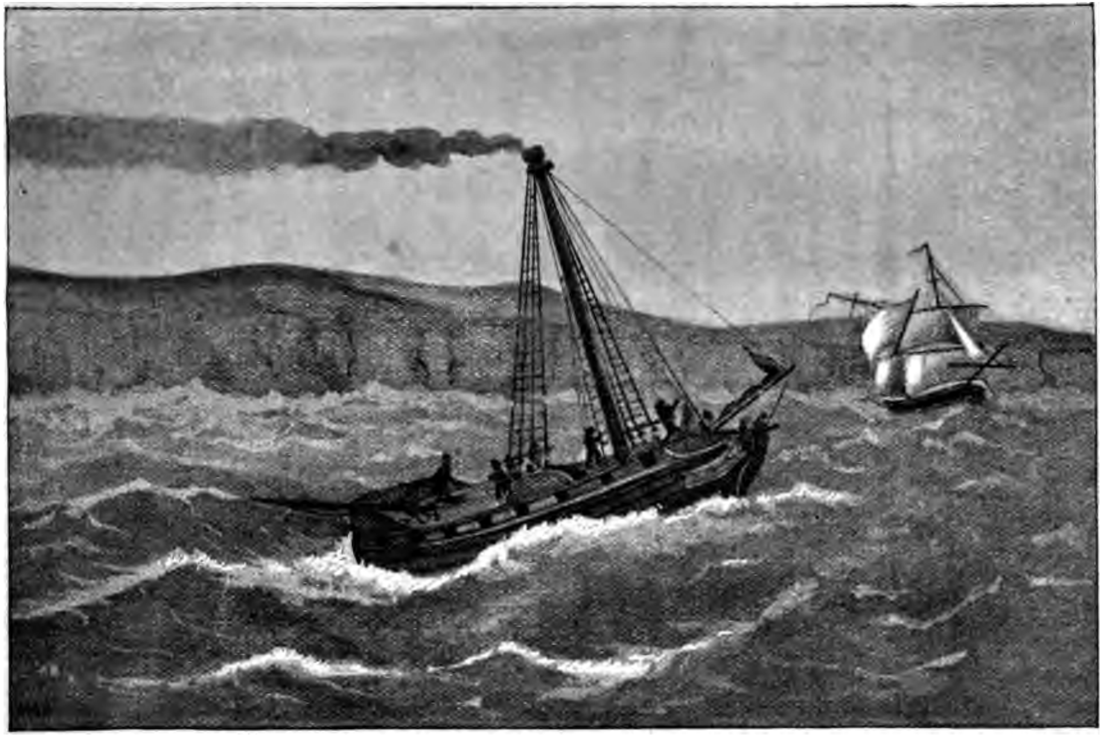
CHAPTER III.

The success of propelling vessels by steam on rivers encourages its employment likewise on the ocean.

PROPELLING vessels by steam on rivers had now become an established fact on both sides of the Atlantic. It had also been tested not only on the waves of the Channel seas but also a short distance outside of them. The first vessel to make what was then considered in the latter case a perilous voyage was the *Thames Yacht,* as she was called, in coming around Land's End to the Thames from Glasgow, where she and her sister ships had been built. To us, nowadays, the legend on the woodcut of this steamer may be amusing; but this was not the case when the incident to which it refers took place. The most remarkable thing in the appearance of this vessel is her cast-iron funnel, used, as in the case of the first Clyde boats, as a mast.

As the successful result of this stormy passage of the *Thames*, the employment of steamers to carry the mails between Holyhead and Dublin, and Dover and Calais, was urged, but without result until 1821. Though the vessels first employed on the service were small—one of them, the *Rob Roy*, for example, built by Napier, of Glasgow, measuring only 90 tons and fitted with an engine of 30 horse-power—the service was nevertheless satisfactorily performed.

A great impulse was given to the use of steam, as a pro-



" The Steam Yacht *Thames* at 5 a.m., 10th of May, 1815, off Port Patrick, weathering the coast by the power of her steam-engine, by George Dodd, Esq."

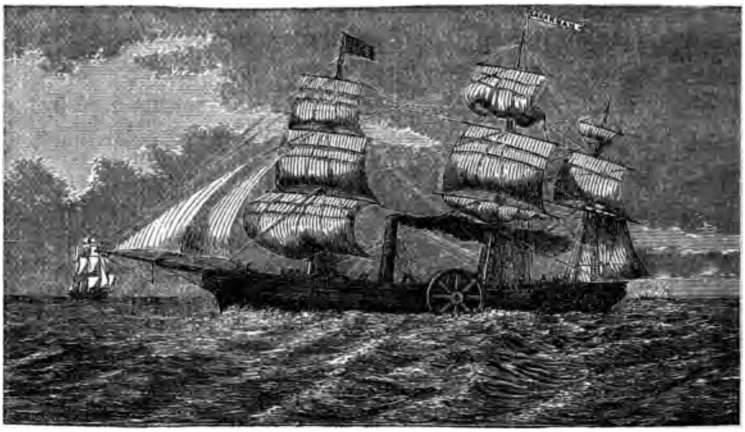
pelling power on the ocean, by the persevering and successful efforts of Stephenson in favour of its employment for locomotion on land by the construction of railways. The prejudices against his proposals, when first mooted, are too well known to require repetition here. His triumph over them, without doubt, largely contributed to deepen the growing impression that steam might be as effectually employed as a motive power on the ocean as it had proved to be on the land. An impetus was, therefore, given to public discussion as to its practical application to Transatlantic voyages.

In this discussion, Dr. Lardner and other scientists took the negative side and demonstrated, chiefly to their own satisfaction as theorists, that ocean steam navigation was impracticable. The elaborate objections which were brought by him to support his views, viewed in the light of the triumphs of ocean steam navigation, are most amusing. But as they are often referred to now as showing the prejudices against it, we give our readers the following concise epitome of them.

His first and leading argument against the practicability of Atlantic steam navigation was based upon the physical condition of that ocean, such as " the atmospheric currents called trade winds, which, as they approach the equator, produce calms, interrupted by hurricanes, whirlwinds, and other violent convulsions." The difficulties of the Gulf Stream, and the weather of the zone of the ocean marked out by it, was, he declared, extremely unfavourable to steamship navigation. Then, in his view, the long swells of the Atlantic, caused by the prevailing westerly winds, which were more disadvantageous to a steamer than the short chopping waves of inland seas. He described the former as masses of water "hurled with accelerating momentum over a tumultuous confluence of waters 3,000 miles in compass," which an immense vessel, forcibly impelled by opposing steam-power, could "neither successfully elude nor safely encounter." He then, in connection we presume with the furnaces of the boilers, pointed to the "calamity of fire, and to the danger of collision with icebergs in the latitudes which steamers must necessarily pass through in crossing to Halifax and Boston." To these difficulties and dangers he added the coating of the boilers with soot, which would impair the conducting power of the iron of which they were made, as well as the liability to leakage through the continued motion of the machinery during the voyages. The anxiety and fatigue of engineers and firemen leading to their neglect of duty was amongst these *à priori* arguments used by this learned philosopher against the possibility and probability of Transatlantic steam navigation.

The first vessel which crossed the Atlantic, fitted with a steam-engine and paddle-wheels, was the *Savannah,* of 350 tons burthen, built at Corlear's Hook, New York, and was at first intended for a sailing packet between that port and Havre. When on the stocks she attracted the attention of Captain Moses Rogers, who had been associated with Fulton and Stevens in commanding the *Clermont* and several others of the earliest steamboats on inland waters. On his advice the vessel was purchased by Messrs. Scarborough & Isaacs, a wealthy Savannah shipping firm, for the purpose of fitting her with engines in order to give that city—then one of the most important American seaports—the credit of being the first to start a line of Transatlantic steamers. Hence the name given to her by the firm. The *Savannah* was rigged as a ship, but with no sails higher than topgallant-sails, steam apparently being intended as an auxiliary in calms or with light head winds. Her mainmast and foremast were more widely separated than on ships designed for sail alone. The former, in fact, stood considerably more aft than it is ordinarily placed in sailing ships, as will be seen in our woodcut, evidently to facilitate the placing of the boiler, engines, and coal bunkers in the middle of the ship and still forward of the mainmast.

Her engine was built by Stephen Vail, afterwards associated with Morse in the invention of the telegraph, at the Speedwell Iron Works, near Morristown, New Jersey. It was similar to our present marine engines, being direct-acting and low-pressure. It had, however, only one cylinder, of forty inches diameter, with a six-feet stroke. Her boilers could carry only a pressure of twenty pounds to the square inch, and one description of them states that they were constructed only to burn wood, that is, "Tamarac," now only used by steamboats on the Mississippi. Another account speaks of seventy-five tons of coal and twenty-five tons of wood having been taken on board for fuel, and in her log reference is made in one entry to her being short of coal. This was on June 18th,



S.S. *Savannah* off Cape Clear, June 17th, 1819.

1819, when the log records that at "4 p.m. Cork bore west to S. 5 leagues distant," and that at "2 a.m. calm, *no cole to git up steam.*" Several boilers were rejected before one was found that would stand the tests made by Captain Rogers. There was such a considerable delay in completing the engines, owing, as it was said at the time, to their unusual size, that it was very late in the winter of 1818–9 before her machinery was in working order.

The paddle-wheels of the *Savannah* were of wrought iron, and comprised eight radial arms, held in place by one flange, and so constructed as to enable them to be closed together like a fan. They were furnished with a series of joints, so that they could be detached speedily from the shaft and taken on deck, when a storm or other circumstances required this to be done; the shaft had a peculiar joint at each end arranged for the purpose. The shipping or unshipping of the wheels was easily accomplished in twenty minutes. Under sail alone the speed of the vessel was, with a fresh breeze, from nine to ten knots an hour; but under steam we have no exact information as to what it was.

The space allotted for her cabin was divided into two saloons—one for ladies and the other for gentlemen—and were handsomely furnished, we are told, with "imported carpets, curtains, and hangings, and decorated with mirrors. Her thirty-two state-rooms were provided with what was then considered luxuriant comforts for a sea voyage." In fact, her cabins were described as resembling those "of a pleasure yacht rather than those of a steam packet."

This historic ship left New York on March 29th, 1819, for Savannah, where she arrived on April 8th. The New York *Mercantile Advertiser* of March 27th, 1819, gave the following notice of her departure on this her trial trip:

"By an advertisement in this day's paper it will be seen that the new and elegant steamship *Savannah* is to leave our harbour to-morrow. Who would have had the courage 20 years ago to hazard a prediction that a ship of 350 tons burthen would be built in the port of New York to navigate the Atlantic propelled by steam? Such, however, is the fact. With admiring hundreds have we repeatedly viewed this prodigy, and can also bear witness to the wonderful celerity with which she moved through the water. On Monday last a trial was made of her speed, and although there was at no time more than an inch of steam upon her, and for the greater part only half an inch, with a strong wind and tide ahead, she went within a mile of the anchoring ground at Staten Island and returned to 'Fly Market Wharf' in 1 hour and 50 minutes. When it is considered that she is calculated to bear 20 inches of steam and that her machinery is entirely new, it may be easily imagined that she will, with ease, pass any of the steamboats upon our waters."

The log-book of the *Savannah* gives us the particulars of this her first voyage to sea. From it we ascertain that the vessel "got under way for sea with the crew on board at 10 a.m., Sunday, March 28th, 1819," and that the pilot left the ship off Sandy Hook Light three hours later, "with fresh breezes at N.W." It is evident that the vessel left under sail, for no mention is made of steam in the log. At four p.m. the sailing-master records that "with fresh breezes and clear" the "Hilands of Never Sink bore N.b.W. 6 leagues distant, from which I take my departure." "Thus," an American writer observes on this entry in the log, "the sailing-master of the pioneer Transatlantic steamship, with a little crew of daring seamen, made the first record in a vessel's log-book of the day and hour in which he last saw land in New York harbour as he took his departure for a distant port."

At eleven a.m. the log records the fact that they "got the steam up and it began to blow fresh; we took the wheels in on deck in 30 minutes." On April 3rd, it states that the weather was calm and pleasant, and that at three p.m. they "stowed the wheels and started the wheels, firld all sail."

The fore and aft sails were, however, set next morning at five o'clock; but the crew at "8 a.m. folded up the wheels and stowed the wheels."

The vessel came to anchor at Savannah at four a.m. on April 6th, eight days and fifteen hours (207 hours) from Sandy Hook, during which the engine was used only forty-one and a half hours.

The *Savannah Republican* newspaper of April 7th, 1819, thus announced her arrival and the popular interest it excited:

"The steamship *Savannah* arrived at our port last evening, after a boisterous passage of seven days from New York. On her approach to the city, hundreds of citizens flocked to the banks of the river, and, while she ascended, saluted her with long and loud huzzas! The utmost confidence is placed in her security. It redounds much to the honor of Savannah, when it is said that it was owing to the enterprise of some of her spirited citizens that the first attempt was made to cross the Atlantic Ocean in a vessel propelled by steam. We sincerely hope the owners may reap a rich reward for their splendid and laudable undertaking."

In the same paper we have the following advertisement on the 19th of May following:

"FOR LIVERPOOL.

"The Steamship *Savannah*, Captain Rogers, will without fail, proceed for Liverpool direct, to-morrow, 20th instant. Passengers, if any offer, can be well accommodated. Apply on board."

No passengers, however, offered themselves, probably from a fear either of the ship being set on fire by her furnaces or blown up by the explosion of her boilers; and, we have reason to believe, carried no freight. Nevertheless, the *Savannah* weighed her anchor two days later than the day advertised, and sailed for Liverpool.

The captain of an American schooner which arrived at Newburyport reports having sighted the *Savannah* on the 29th May, in lat. 27° 30′, long. 70°. She was then ahead to eastward, with volumes of smoke issuing from her. Concluding it was a ship on fire, he stood for her in order to afford relief; "but," observes the captain, "found she went faster with fire and smoke than we could do with all sail set! We then discovered that the vessel on fire was nothing less than a steamboat crossing the western ocean, laying her course, as we judge, for Europe, a proud monument of Yankee skill!"

The London *Times* of June 30th, 1819, thus announced her arrival:

"The *Savannah*, a steam-vessel recently arrived at Liverpool from America—the first vessel of the kind which ever crossed the Atlantic—was chased the whole day off the coast of Ireland by the *Kite*, revenue cruiser on the Cork station, which mistook her for a ship on fire."

The sailing-master, Stevens Rogers, thus described her arrival off Cork on June 17th, in a communication to a Connecticut paper, after the arrival at New York of the *Sirius* and *Great Western*:

"She (the *Savannah*) was seen from the telegraph station at Cape Clear, on the southern coast of Ireland, and reported as a ship on fire. The admiral, who lay in the Cove of Cork, despatched one of the King's cutters to her relief; but great was their wonder at their inability, with all sail set, in a fast vessel, to come up with a ship under bare poles. After several shots were fired from the cutter the engine was stopped, and the surprise of her crew at the mistake they had made, as well as their curiosity to see the singular Yankee craft, can easily be imagined. They asked permission to go on board, and were much gratified by the inspection of this novelty."

On June the 18th the sailing-master announced, as already quoted from his log, that when off Cork there was "no cole to git up steam." This must have been a great disappointment to Captain Rogers, who, after his chase by His Majesty's cutter, would doubtlessly wish to run up channel under steam. We find, however, that "with all sails set to the best advantage," the *Savannah* hove to at two p.m. "off the bar for the tide to rise." The log then states that at "5 p.m. shiped the wheels, firld the sails, and running to the river Mercer at 6 p.m. came to anchor off Liverpool with the small bower anchor." This made the run 29 days 11 hours from Savannah to Liverpool, during which the engine worked the wheels only 80 hours.

While the *Savannah* lay to, waiting for the tide to cross the bar, she had her colours flying, and a boat from a British sloop-of-war came alongside and hailed her. The sailing-master ran on deck and held the following laconic conversation with the officer:

"Where is your master?" inquired the officer.

"I have no master," was the reply.

"Where is your captain, then?"

"He's below. Do you wish to see him?"

"I do, sir."

The captain, who was below, then put in an appearance, and asked the officer what he wanted with him.

"Why do you wear that pennant, sir?"

"Because my country allows me, sir," answered the captain.

"My commander," replied the officer, "thinks it was done to insult him; and if you don't take it down he will send a force that will do it."

The captain then called out to the engineer, "Get the hot-water engine ready!"

"Although," adds the sailing-master, "there was no such an engine on board the vessel, it had the desired effect, for John Bull paddled off as fast as possible."

On approaching Liverpool the shipping, piers, and roofs of houses were thronged with persons cheering the adventurous craft. Several naval officers, noblemen, and merchants from London came to visit her, and were curious to ascertain her speed, destination, etc. As it was soon after her arrival that Jerome Bonaparte had offered a large reward to any one who would carry off his brother from St. Helena, the *Savannah* was suspected of having some such object in view, and during her stay of twenty-five days at Liverpool was consequently jealously watched by the authorities.

On July 21st the *Savannah* weighed anchor and dropped down the Mersey, bound for St. Petersburg, and arrived at Elsinore on August the 9th. Here she remained in quarantine until the 14th, and then sailed for Stockholm, reaching that place on the 22nd.

Six days after her arrival, her log records at noon that "H.R.H. Prince of Sweden and Norway visited the ship." On September the 1st she went on a pleasure trip, "having on board many of the Royal family, Russian nobles, officers, and foreign ministers to the Swedish Court. Four days later she left for St. Petersburg, taking with her Sir Thomas

Graham (Lord Lyndock), then on a tour through the north of Europe. The sailing-master informs us that on the passage he expressed a wish to see the vessel brought from steam to canvas, and that his lordship "held his watch and noted the time—15 minutes, and was so delighted that he exclaimed, 'I blame no man born in the United States for being proud of his country, and were I a young man I would go there myself.'"

The *Savannah* arrived at St. Petersburg on September the 13th, and was manœuvred for three days in the harbour under steam, having on board many of the Royal family, Russian nobles, and other distinguished personages.

During her voyage of thirty-three days from Liverpool to St. Petersburg, steam was used more continuously than on the former voyage, or for about ten days (239 hours). On the 10th of October she sailed for Savannah. The homeward voyage was a stormy one, and the engines were not used on any single occasion during it until November the 30th, when, as the log informs us, Captain Rogers "took a pilot inside the bar," and "at 10 a.m. anchored in the Savannah river, and firld sails on the flude tide, got under way with steam and went up and anchored off the town."

Owing to the pecuniary embarrassment of her owners, consequent upon the great fire at Savannah in 1820, she was sold, her engines taken out, and employed as a sailing packet between there and New York, and subsequently lost on Long Island.

Although novelty and adventurous daring render this voyage of the *Savannah* of some interest, it indicates on both sides of the Atlantic a popular craving for the application of steam to ocean navigation. It is only out of courtesy that the vessel can be called a steamship. As in the instance of the first application of the screw as a propelling power for large vessels, her engines and movable paddle-wheels were only used in calm weather, and can therefore only be regarded as auxiliary to her canvas.

Nor can it be said that the result of the attempt was indicative of eventual success in Transatlantic steam navigation. It was not, indeed, until fourteen years later that the Atlantic was crossed by a regularly built steamship. Before referring to this important event, let us concisely call attention to the condition and extent of steam navigation at the period marked by the voyage of the *Savannah.*

In 1820, the number of steam vessels owned in the British Empire was but forty-three, with an aggregate of 7,243 tons, as compared with six vessels in 1814, with a total of 673 tons. The subsequent progress in steam navigation was, however, very rapid.

In 1822 the first large Channel steamer, the *James Watt*, was built, to run between Glasgow and Leith. This vessel excited great admiration in her day, and pictures of her under full sail and steam are still extant. Her dimensions were but 448 tons, and she was fitted with two engines of fifty horse-power each, which were made by Boulton & Watt, of Soho.

The *James Watt* proved so complete a success that shortly after she was built, a sister ship, the *Soho,* was placed upon the route. Four years later (1826), the steamship *United Kingdom* was built, and from her so-called "gigantic proportions" excited at the time as much wonder and interest as the *Great Eastern* did when she was launched. The size of this leviathan of her day was, however, only as follows: Length, 160 feet; breadth, 26½ feet. Her engines were only 200 horse-power. She was therefore only about half the size of the first vessels of the Cunard line.

Until these vessels were built, steam navigation had been confined to crossing the Channel between Dover and Calais, and Holyhead and Dublin, and to Glasgow and Belfast from Liverpool. Its adoption, therefore, in place of sailing vessels, between what was then considered such distant points as London and Leith, are indications of a bolder development in its history. The next forward step was to be its application to Transatlantic communication. The rapid settlement of North America, and the consequent increase of its trade, powerfully pleaded for the attempt being made.

The sailing vessels, which not only carried all the merchandise and passengers but also the mails on this route, were allowed nine to ten weeks for the round voyage when carrying the latter, although more rapid passages were made by the "Liners," as the regular sailing ships were called. As commerce increased between the two countries the latter were enlarged, and greatly improved both in build and in their accommodation for both cabin and steerage passengers. In this respect, and especially for the latter class, they excelled that supplied by transient vessels. Liverpool on this side of the Atlantic, and New York chiefly on the other, were the chief ports between which they sailed.

This fleet of regular sailing packets comprised a number of competing lines. There was the "Shakspeare Line," called after some of the poet's characters, and the "Dramatic Line," named after distinguished actors like Roscius, Garrick, Siddons, and others. There was also the "Black Ball Line," with a black ball as its distinguishing mark on the foretopsail. Its ships were named after English and American cities, such as London, Oxford, and Yorktown. In their day these vessels were as celebrated for their respective size-

or speed as our crack American steamships are now. They had also their celebrated and popular captains, of whom the passengers who sailed with them had always something to say, and were expected to say it. Of these were Captain Bailey, or Old Captain Bailey, as he was generally spoken of, and Young, of the *Oxford.*

Their quick runs across the Atlantic excited great interest, as for example that of Captain Bailey, in the *Yorktown*, in thirteen and a half days from Sandy Hook to Holyhead—the Queenstown of that day; and another by Captain Young, in the *Oxford*, in fourteen days. These were, of course, exceptional voyages, but the run between these points was often made in from seventeen to twenty-four days to the eastwards, and from twenty-two to thirty-three days to the westwards.

The captains of these packets got the credit for the quick runs they made, now only given to our fast steamers on account of their build, model, and the power of their engines. And they fully deserved this personal acknowledgment, for their success did not depend, as in the latter case, upon the uniform power of steam, but upon the fickle winds and the management of their ships. This required judgment, experience, and all that comprises good seamanship.

And how these Yankee skippers "cracked on the dimity," as they called their sails, royals, skysails, studding-sails, and all, piling Ossa on Pelion, and "carried on" to the utmost limit of prudence, and often beyond it!

It was something worth talking and boasting about to make an Atlantic voyage in those days. Men before venturing upon it weighed its probabilities, and solemnly made their wills in view of its uncertainties. Nearly three months elapsed before their friends or expectant legatees could be informed of their safety or fate. There were fixed days of sailings for the packets, but not, as now in the case of our Atlantic steamers, fixed days of arrival.

In fact, the sailing packet might reach Halifax, Boston, or New York in three weeks, or it might be in seven, for everything depended upon the weather and winds they encountered in making the voyage.

The cabins of these liners were so largely in advance of those of any other ships of the day, that they were looked upon as superb. One enthusiastic American writer of the period, in a fit of national gallantry, thus referred to them:

"The wives of the ship captains of New York form a body, if they could be seen in a group, of the most beautiful women in existence. To this we have long since philosophically attributed the splendour and beauty of the packet ships. Elegant women naturally communicate their tastes and style to their husbands, who in this state of charming magnetism infuse this influence of taste into the finish of their ships' cabins."

Their models, rigging, and all their appointments were also very great improvements on those of preceding sailing ships, and they were also built with a view to great speed as well as cargo capacity. And even after steam began to threaten their trade these improvements went on and reached a climax in the construction of the clipper ship *Great Republic* in 1854. This vessel excited much interest on account of her great size and peculiar rig, and had four masts. She resembled an ordinary American clipper except in her great sheer forward from the fore-chains to the figure-head. Her broad beam equalled that of the largest line-of-battle ship afloat at the time. Her topsails were divided into two, so that the upper one could be reefed to half its size, or sent down altogether. There was also a large hurricane-house on deck, and abaft the mainmast a rain-house, in which was an eight horse-power engine which did all the heavy work of the ship—lifting her yards, hauling on to her braces, walking up the anchor, and aiding in the loading and discharging of her cargo. Her size was 3,400 tons; beam, 53 feet; length, 305 feet; and hold, 30 feet deep. In March, 1855, she made the run between New York and Scilly in thirteen days, and beat up Channel to the Downs, against a stormy east wind, in three days. The *Great Republic* could not dock on her arrival on the Thames, on account of her breadth and her draught of twenty-five feet, but had to anchor in the "Long Reach."

The steward's department in the old sailing packets fully met all the requirements of cabin passengers, who did not expect first-class hotel accommodation at sea as they now do, but were contented with a fare which would not now be tolerated by Transatlantic voyagers even in fourth-class steamers.

Biscuits were then used as the sea substitute for bakers' bread, those for cabin passengers being finer in quality than the "hard tack" supplied to the crew. In course of time baking hot rolls for the cabin was introduced, and regarded as a wonderful improvement in Atlantic catering.

As compared with the comforts emigrants to America have now in crossing the Atlantic, they had a hard time of it in these days of sailing ships. The earlier steerage passengers had to provide themselves with food for the voyage, and often, through a miscalculation as to its duration, suffered a great deal from their supplies falling short. In order to prevent this an Act of Parliament was passed, obliging all vessels carrying emigrants to supply them with a daily ration and a galley fire for their special use. And many lively scenes have we witnessed round this fire as each emigrant struggled to get his or her pot or pan on it! And equally amusing were the scenes on the stated days on which rations were served out to these adventurers and hardy pioneers of the West, as one of the mates weighed out to them their allowances of flour, beans, rice, etc.

In stormy weather their sufferings may be imagined when the hatches were battened down, and the scores, and sometimes hundreds of men, women, and children were often kept for days in a stifling atmosphere. When the voyages were prolonged by adverse winds, many of these sailing ships became floating pest-houses. Ship or typhus fever, small-pox, or some other fell disease, fed by the surroundings of their victims, slew scores and even hundreds of them during the voyage, or when detained in quarantine on arrival. Still in the face of all these discomforts, dangers, and drawbacks, they went in thousands across the ocean to seek homes in the western land of promise, and by their Anglo-Saxon enterprise largely contributed to the growth of the great American Republic and our Dominion of Canada, and thus built up that over-sea traffic between us and them, under which Atlantic steam navigation has so prospered and grown.

CHAPTER IV.

Experimental proof of the feasibility of Transatlantic steam navigation results in its practical adoption and proposed extension to the East.

In the course of our narrative we now come to the experiment which proved, not only the feasibility, but also the possibility of Transatlantic steam navigation. The successful voyages of the *Sirius* and *Great Western* steamships have generally been credited with having done so, but, as will be seen, the honour of solving these problems belongs to the Canadian steamship *Royal William*, which crossed the Atlantic in the autumn of 1833, or two years previous to the voyages of the former two vessels.

This pioneer steamer was built at Quebec during the winter of 1832–3, and she was launched at the end of April in the latter year. The importance attached to the event is shown by the fact of Lord Aylmer and a large number of people of all ranks being present on the occasion, as well as the band of the 32nd Regiment.

The Quebec Mercury, in its issue on April 31st, 1833, in describing the launch, gave the dimensions, etc., of the *Royal William* as follows:

"Builder's measurement, 1,370 tons; steamboat ditto as per Act of Parliament, 830 tons; freight capacity, after deducting space for seven days' fuel, water, provisions, and accommodation for 60 passengers, was 300 tons; length of keel, 146 feet; deck, 162; over all, 176 feet; breadth inside paddle-boxes, 27 feet; outside of ditto, 43 feet 10 inches; depth of hold, 17 feet 9 inches; draught when launched, 7 feet 9 inches, and with engines and full cargo on board, 13 feet."

This notice of the launch further stated that the *Royal William* would proceed to Montreal (180 miles up the St. Lawrence) in tow of the steamboat *British America*, when her engines would be put on board and her cabin fittings completed. These engines of 180 horse-power, made by Boulton & Watt, of Birmingham, were fitted up in her at the St. Mary's Foundry, Montreal, where the author was taken to see her in May, 1833, by his father, and distinctly remembers spelling out her name from the big letters in which it was displayed on her paddle-boxes.

Until her historical voyage across the Atlantic in the autumn, as stated, of 1833, the *Royal William* was, in accordance with the original intentions of her owners, placed on the route between Quebec and Pictou, Nova Scotia. For some reasons not recorded, probably, however, because of its failure as a commercial enterprise, she was taken off it and despatched from the former port to London on August 5th, 1833. Her arrival was duly announced in *Lloyd's Register* of that year on September 12th, as follows: "Gravesend, September 11th, Steamship *Royal William*, Captain Macdougall, from Quebec."

The impression produced by this voyage across the Atlantic of the first regularly built steamship was referred to as follows in the *Annual Register* for 1833 (p. 491), under the heading, "Communication with America by Steam":

"The steamer *Royal William*, of 180 horse-power, has recently arrived at London from Quebec. On her way she touched for fuel at Pictou, in Nova Scotia, where she obtained at fifteen shillings per chaldron coal raised on the spot, the quality of which is pronounced by the engineer on board to be superior for generating steam even to our English coal. From Pictou she came direct to Cowes, Isle of Wight, in seventeen days. The distance is about 2,500 miles, and therefore this voyage is not instanced for its speed, which was not the particular object of the vessel on this occasion, but proves three important facts: First, that there is no more difficulty in conveying the mails by steam to our British American possessions than to our dependencies in and about the Mediterranean, for which service steam packets are used. Secondly, that the nine weeks—Post Office average allowance for the sailing packets to and from Halifax—might, by the adoption of steam, be reduced to a regular passage of five weeks out and home. Thirdly, that for the coal supply of the steam packets to our North American possessions, there exists in our colony of Nova Scotia coal mines yielding excellent fuel for the purpose at a cheap rate."

The voyage of this Canadian steamer may therefore, for the reasons above stated, be regarded as having prepared the way for Transatlantic steam navigation. We may mention in passing that the late Sir Samuel Cunard, to whom reference will be made further on, was one of the directors of the Quebec and Halifax Steam Navigation Company, by which she was built.

It is interesting to notice before passing to the second leading incident in this narrative that the *Royal William* was bought by the Spanish Government as an addition to its fleet during the first Carlist war, and fitted at Sheerness Dockyard as a man-of-war and pierced for six long thirty-two pounders. Her name was changed to *Isabella*, and Captain Macdougall, who had sailed her from Quebec to Gravesend, "staid by her in the capacity of sailing-master and paymaster, as did several of her crew." He afterwards acted as naval instructor to the Royal Mail (West Indian) Company, having his headquarters at Southampton, where he died.

The last the author saw of this pioneer of Atlantic steam navigation was as a wreck on the rocks off the harbour of Alexandria, when our fleet sailed in to bombard its forts in July, 1882.

The year 1833 was marked by another event connected with the commencement of Transatlantic steam navigation of some interest, not only in itself, but to our American cousins. We refer to the efforts made that year by Mr. Junius Smith, LL.D., to secure this great object. He was an American by birth, but had resided in London up till this period since 1805.

On returning from New York in January, 1833, by a sailing ship to Plymouth, after a voyage of thirty-two days, he wrote back thus to a friend in New York:

"Thirty-two days from New York to Plymouth and forty days to London is no trifle. Any ordinary sea-going steamer would run it, in the weather we had, in fifteen days with ease. I shall not relinquish the project unless I find it absolutely impossible."

After giving the subject further attention, Dr. Smith introduced his scheme to leading business men and bankers in London and to merchants engaged in the American trade. The prospectus he submitted to them proposed the formation of a company with a capital of £100,000 to build steamers of only 1,000 tons burthen. Although it embodied facts and figures in support of the project it only provoked unqualified ridicule, as well as strong opposition from those interested in the existing sailing packets.

In no wise discouraged by this opposition, Dr. Smith issued another prospectus with a bolder project, for it proposed a company with a capital of £1,000,000 sterling to build steamships of from 1,800 to 2,000 tons burthen. This was based on statistics of the trade between the United Kingdom and America. The arguments deducible from them were undeniably in favour of the project. The only direct issue raised against it was the possibility of crossing the Atlantic at all by steam. Dr. Smith had no precedent to quote in favour of it, excepting the safely made voyage of the *Royal William* and the success of steamers in the Channel and along the coast. It seemed at first too formidable an obstacle to be easily removed, and was strongly maintained on this side of the Atlantic. For example, Dr. Lardner in a lecture at Liverpool in December, 1835, said: "As to the project which is announced in the newspapers of making a voyage directly from Liverpool to New York by steam, I have no hesitation in saying it is perfectly chimerical, and they may as well talk of making a voyage from New York or Liverpool to the moon!"

Even the Duke of Wellington, with all his marvellous powers of mind and thought, stated, in reply to a letter from Dr. Smith, that he "would give no countenance to any schemes which had for their object a change in the established system of the country."

In the face, however, of all the difficulties he encountered in bringing his project before the public, Dr. Smith eventually succeeded in organising a company to carry it out, on the basis of a second prospectus, under the name of the "British Queen Steam Navigation Company." The capital was fixed at £1,000,000 sterling, divided into a thousand shares of £100 each. Amongst the directors appear the names of Charles Enderby, the maternal grandfather of the late General Gordon, and of the well-known Mr. Macgregor Laird as its secretary.

The subscription books of the really pioneer Atlantic steamship company were opened to the public in London, Liverpool, and Dublin in July, 1836. The shares were so promptly taken that in a short time a sufficient number was sold to warrant the directors contracting with Messrs. Curling & Young, of Blackwall, London, for the building of the Company's first steamship, the *British Queen*. They contracted for her engines with Messrs. Claude Girdwood & Co., of Glasgow. After completing about two-thirds of the work the latter firm became bankrupt, when a new contract for them was made with Mr. Robert Napier, then the most renowned engineer on the Clyde.

In a third prospectus the objects of the Company were stated to be the regular and certain communication by steamships between Great Britain and the United States, and that the vessels were "intended to depart from London, Liverpool, and New York," and that their passage was not to exceed fifteen days. It also called attention to the Company's first vessel, the *British Queen*, of 1,862 tons measurement, with engines of 500 horse-power, which was then "fitting up for the London and New York line," and which "would commence running upon the station in the course of the summer."

She was described as having a capacity for 500 passengers, 25 days' fuel, and 800 tons of measurement goods, exclusive of provisions, etc.

As the building of the *British Queen* progressed the views of the directors became so enlarged that instead of a vessel of 1,862 tons, as proposed in the prospectus, one of 2,400 tons measurement was built.

The delay caused by the failure of the first contractors for her engines determined the directors to charter the steamship *Sirius* for a voyage to New York, in order to save the prestige of their Company, in view of the fact that the ship of their rivals at Bristol, the *Great Western*, was then almost ready for sea. It was also intended by them that this voyage should also be an experimental one, about the success of which, however, they had no misgivings.

The *Sirius* belonged to the St. George Steam Packet Company, engaged in the trade between London and Cork. She was built at Leith by Menzies, and was 178 feet long, 25½ feet broad, and 18 feet in depth, and measured 703 tons register. She was fitted with engines of 320 horse-power by Messrs. Wingate & Co., of Whiteinch, near Glasgow. Their cylinders were 60 inches in diameter, and had a stroke of 6 feet. Her paddle-wheels were 24 feet in diameter, and her boiler pressure was but 15 pounds to the square inch. Sailing from London on her celebrated voyage on April 4th, 1838, she arrived at New York on the 21st of that month, after a stormy passage.

The steamship *Great Western*, which followed the *Sirius* three days later, was built at Bristol after designs by Mr. Brunel, and her engines were supplied by Messrs. Maudslay, Sons, & Field, of London. They were the side-lever type, having two cylinders 73½ inches in diameter, with a stroke of 7 feet, and worked up to 750 indicated horse-power.

It was meet that Bristol, the birthplace of the Cabots, and where even the attention of Columbus had been so forcibly called to the existence of a great continent beyond the western ocean, should be amongst the first in despatching a regularly built steamer to open communication with it.

Bristol had also a direct interest in undertaking such a new and adventurous enterprise, for its merchants had at the time a very large share in the American trade with the United Kingdom. In fact, at the time as a port it virtually occupied, in connection with that trade, the position which Liverpool now does.

The *Great Western's* dimensions were as follows: length, 236 feet; breadth, 35⅓ feet; and depth of hold, 23¼ feet, with a measurement of 1,340 tons. Her paddle-wheels were 28 feet in diameter, and their paddles 10 feet long.

Both the *Great Western* and *British Queen* excited a large amount of public interest in their day, for they were then looked upon, as well they might be, as wonderful achievements of British engineering skill and enterprise. For example, in an article in the *Annual Register* the latter is described as "one of the largest ships in the world, her length, it is said, exceeding that of any ship in the British Navy," although her length over all was but 275 feet, and on deck 245 feet. This would be only about half that of the present Liverpool and New York steamships. Her draught was but 16 feet when ready for sea, while that of the latter varies from 23 to 33 feet. This article then thus grandiloquently referred to the launch of the vessel: "The signal being given, the stupendous vessel took leave of her moorings, and was named by the Honourable Mrs. Dawson Damer the *British Queen.*"

The descriptions given of the *Great Western* were quite as glowing as were those about her great rival. A writer of the day, after stating that her saloon was 75 feet long by 21 feet broad and 9 feet high, remarked that:

"This superb saloon is tastefully decorated, and fifty principal panels are adorned with paintings from the well-known pencil of Mr. Pavris. The splendour of this floating palace's interior is truly striking."

The date of the sailings of both the *Sirius* and *Great Western* had been transmitted to New York, and soon became widely known. Their arrival was anticipated with so much interest that vast numbers congregated daily on the "battery"* and gazed wistfully in the direction of the "Narrows," a strait between Staten and Long Islands leading from the Bay of New York to the ocean.

For several days their vigilance was unrewarded, but at last the enthusiastic watchers saw what appeared to be a streak of smoke on the horizon. At first it was scarcely perceptible. The faint sign, however, became steadily and rapidly intensified, and at length developed into the hull of a steamship, the revolving wheels of which were soon discernible. Then the cry of "Here she is!" was heard from the expectant crowd. The news now spread quickly through the city, and thousands hastened to the "battery" in order to welcome the arrival of the expected nautical novelty.

The vessel was the *Sirius.* Scarcely, however, had the citizens recovered from their surprise when the *Great Western* appeared. Cheer after cheer arose as the gallant ship steamed slowly up alongside of her rival, and then, amidst the greatest enthusiasm, with bells ringing and men cheering—as only Anglo-Saxons can—and the thunder of cannon, the New Yorkers welcomed the elated passengers as they landed from both steamers.

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* The narrow eastern end of the site of New York between the east and north rivers, from which vessels from the Atlantic are first seen entering the Bay, and then a fashionable promenade.

And such enthusiasm was warranted by the event, for both vessels were looked upon by the New Yorkers as hands stretched out by England to America, welcoming her to her proper place in the comity of nations, and as another link in that chain which binds so closely together the great Transatlantic branch of the Anglo-Saxon race to its parent stem.

We have no record of the incidents in the passage of the *Sirius* save that although it was a very stormy one, her paddle-wheels and boxes received no injury from Lardner's big Atlantic waves, and that she had proved herself in other respects to be thoroughly seaworthy. It is, however, known that her crew became mutinous shortly after leaving port, in view of the continuous head-winds encountered by the ship, and declared it was madness to proceed in so small a vessel. Lieutenant Roberts, R.N., however—like Columbus under similar circumstances—by stern discipline and persuasion, was enabled to quiet their apprehensions.

With respect, however, to that of the *Great Western* we have fuller information, from which we learn that she made the run between Bristol and New York in a few hours under fifteen days, logging 3,125 nautical miles. Her speed averaged from 8·2 to 9 knots an hour, with a daily coal consumption of from twenty-seven to thirty-two tons.

This historical steamer—for such she is in connection with the regular establishment of steam navigation on the Atlantic—continued to ply between Bristol and New York from 1838 to 1844, during which time she made no fewer than seventy passages between these ports, carrying each time an average of eighty passengers.

The equally celebrated *Sirius*, being too small a vessel for the service, was soon withdrawn from it, and was subsequently lost on the Irish coast. The *British Queen* was placed on the route immediately after she was finished, and her owners, encouraged by her success, built the ill-fated *President*, on the Thames, in 1839. Her dimensions were: length, 265 feet; tons, 2,366; engines, 540 horse-power. She made her first voyage to New York in seventeen days; but on her return trip in March, 1841, was lost, with 136 souls on board. Some supposed that, owing to her length, she "broke her back" in the rough weather she encountered, and others that she struck an iceberg and foundered.

We have now brought our readers to that important epoch in navigation when the value of steam as a motive power for vessels, even on the ocean, had been practically recognised. Roger Bacon had anticipated such an eventuality, and the poet Darwin had, thus early in this century, given expression to the general feeling roused by improvements in the steam-engine:

> Soon shall thy arms unconquered steam afar,
> Drag the slow barge and drive the rapid car.

And these improvements in that engine which was destined thus to revolutionise the social, political, and commercial relations of mankind, were eloquently descanted upon at the period with which we are dealing by many writers. One of them in the *Edinburgh Review*, supposed to be Mr. Francis Head,* affirmed that if it were contended between England, France, and Germany who should take precedence amongst the distinguished names which have adorned our intellectual and social progress, Europe and America would together pronounce the name of Watt as the most illustrious of benefactors. This writer, however, calls attention to the fact that his pre-eminence was not the result of any brilliant conception, or any felicitous creation of the mind to which the name of invention or discovery could be distinctively applied. Watt he described as only an improver—not the inventor of the steam-engine. He found the engines of Savery and Newcomen labouring and squeaking at mine-heads, and occupying the same rank as prime movers with water-wheels and windmills. By a succession of inventions and discoveries he brought the steam-engine to such a degree of perfection as to stamp it as "the most precious gift man ever bequeathed to man." And it is so, in his opinion, because "It serves us at all times and all places . . . surpasses all others as a stationary power, rises above all as a locomotive power. It can draw along overland a hundred waggons, and it manifests the same power on the boundless ocean:

> Calm or convulsed, in breeze, or gale, or storm,
> Deep heaving——"

If again, as this enthusiastic writer adds, the gods of antiquity were now replaced, Watt would appropriately occupy the place of Neptune with a column of vapour for his trident and a steamship for his throne! "That trident," he adds, "would be but a bucketful of water whose elastic breath defies tides and tempests — thus contracting the aqueous dimensions of the globe, wafting to remotest shores the truths of inspiration and reason, and hastening that era of peace when the Philosopher and the Savage would be united in the brotherhood of faith and charity."

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* Subsequently known as Sir Francis Bond Head.

Even the staid *Athenæum*, in 1839, shared in this general feeling of satisfaction at the prospects opened up by the application of this new motive power. "Steam navigation," it remarked in one of several consecutive articles on the subject, "hitherto in its infancy, is now rapidly advancing to gigantic maturity, and the future achievements of the infant Hercules may readily and safely be predicted from the growing feats of the Athletic Youth. It is manifest that this globe of ocean and earth is about to be enclosed in a continuous network of communication by steam. The wild waves around the Southern Cape of Africa are to be the bearers of a line of communication with Eastern India, 'AS REGULAR AS A STEAM COACH ON A RAILWAY.'

"The mazes of the Coral Islands in the sleepy Pacific will soon be threaded by the tracks of British steam-vessels, and the plash of their paddles will break on ears that hitherto have only heard the gentle ripple made by the Indian in his canoe.

"Not content with her recent conquests in the West, steam is about to extend her dominion to the far East. Mercantile companies are about to undertake enterprises of such a gigantic extent as even Governments of great power have hitherto not contemplated. Steam-vessels of a size and capacity of 2,000 tons are now suggested as the only profitable and practicable size, and these suggestions are borne out by minute and detailed calculations. One of the companies, for example, propose to sail from Plymouth to Calcutta, round the Cape, in 55 days, and another by the Red Sea to reach Ceylon in 36, Madras in 40, Bombay in 42, and Calcutta in 43 days."

The notion of establishing steam communication with India had long engaged the attention of its British residents, and that of the Home Government. Its possibility had been proved by a voyage made in 1825 of a steamer called the *Enterprise*, which made a voyage from England to Calcutta in 113 days, 64 days under sail, and 49 days steaming. She was only 500 tons register, and was fitted by Messrs. Maudslay, Sons, & Field, with engines working up to 240 indicated horsepower. No second voyage, however, was attempted.

Although a Parliamentary Committee had reported very favourably on the subject, the public were not inclined to invest money in the establishment of a line of steamers to connect the mother country with her great Asiatic dependency. Amongst the refusals was that of the East India Company itself.

Much of this opposition to the introduction of steam on the route to the far East came from the owners of the fleet of sailing ships who had then a monopoly of its carrying trade. They naturally feared that the new propelling power would disastrously interfere with their interests, and did what they could to discourage its introduction. Although these bluff-bowed East Indiamen have now been displaced by steamships, and live only in many of the romantic and daring incidents of ancient sea adventure, the influence they exerted in their day was not to be despised. They were, in fact, very superior merchant craft, so strongly manned and armed as to be barely distinguishable from the wooden warships of the period. They got under weigh in the most approved man-of-war fashion, setting and shortening sail in the twinkling of an eye to the shrill sounds of the boatswain's whistle. Occasionally they flew the St. George's ensign of the Royal Navy at their mizen peak, and passing cargo craft would lazily lower their light sails in courteous recognition of the rights of a flag so celebrated in song and history. Their officers and crew, also, were wont to regard with disdain the less fortunate navigators of cargo-carrying ships, for passengers then yielded better returns than freight, for often £300 were paid for an unfurnished stern cabin by passengers from Calcutta to London. Steam, however, has now effectually taken the wind out of the sails of these old swells of the ocean.

The success, however, of Transatlantic steam navigation gave such an impetus to the movement that soon afterwards the rich merchants of East London united with those of East India to bring about a closer union "in time and space," between the British family at home and the numerous members of it in Hindustan.

Two routes were proposed, one by the Red Sea, and the other round the Cape of Good Hope, the former being suggested by a Mr. W. D. Holmes, the three main features of which were as follows:

1. Independence of Government and Indian subsidies.
2. In the size of the vessels used in the service.
3. The employment of iron instead of wooden vessels.

Hitherto only vessels of from 600 to 1,000 tons had been proposed for the service; but Mr. Holmes urged that they should be of at least 2,617 tons and of 600 horse-power. Another important point in his proposal was the overland route through Egypt from Suez, viâ Cairo to Alexandria. The steamers were to call at Cosseir on the Red Sea and land their goods and passengers at Suez. Alexandria was to be reached by the Canal from Cairo. It was calculated that the time between Calcutta and Falmouth would be about four weeks and three days. Mr. Holmes, however, at the same time while suggesting this overland route, evidently regarded it as a temporary expedient, for he called attention at the same time to the facility and importance of cutting a canal across the Isthmus of Suez in order to avoid the transhipment of passengers and freight.

Sir J. Ross advocated the route round the Cape of Good Hope to Calcutta from Plymouth, the length of the voyage being 13,035 miles, which, by steaming ten knots an hour, could be accomplished in fifty-two days.

Mr. Holmes's plan, however, as we shall see further on more in detail, was adopted and acted upon until the construction of the Suez Canal. We must, however, return to those incidents in the development of ocean steaming which took place after the successful voyages of the *Royal William*, and her successors the *Great Western* and *Sirius*.

CHAPTER V.

Initial and other incidents of the Victorian iron-ship and screw-propelling period.

THE building of the *Great Western*, at Bristol, was followed by that of the *Great Britain*. Her keel was laid in 1839, and when she was launched in 1843, by a strange oversight, her breadth was found too great to permit her exit through the dock-gates. Great ingenuity had consequently to be exercised by leading engineers before she could be liberated from her prison. She was intended for the American trade, and made several voyages to New York. Unfortunately, when leaving Liverpool for that port in the winter of 1847, she was run ashore in Dundrum Bay, Ireland, where she lay for some months exposed to the wintry gales; but was eventually got off the rocks without having suffered much injury, and was then put on the Australian trade, in which she continued until condemned as unseaworthy a few years ago.

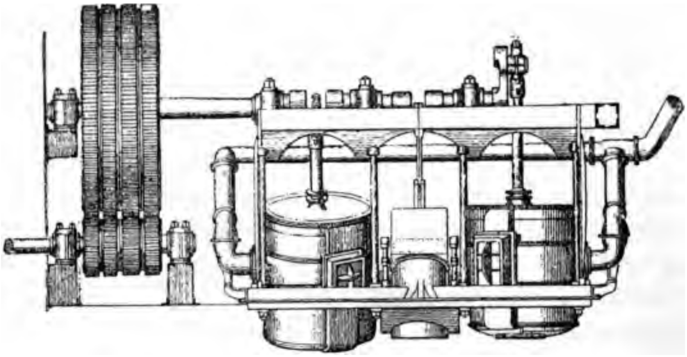
The construction of the *Great Britain* was considered, at the time, as another of "the most gigantic achievements of the day," although her length was but 322 feet, her moulded breadth 51 feet, and her depth of hold 31½ feet. She was modelled in the old man-of-war fashion, with tumbled-in, or "lop" sides, and measured 3,270 tons gross. Her engines indicated 1,500 horse-power, and burnt 65 tons of coal per day. They had three double-ended boilers, with furnaces at each end, with a pressure of 25 pounds to the square inch. In two respects this steam vessel differed from her predecessors, first, in being fitted with a screw propeller instead of paddle-wheels, and next, in being the first ocean-going vessel constructed of iron.

Iron vessels had been used early in this century for canal service. They were later on adopted for that on rivers, and subsequently for packet services on the coast. In 1838 a number of small sea-going vessels made of iron put in an appearance. It was not, however, as stated, until 1843, when the *Great Britain* was built under the superintendence of Brunel, that we have for the first time a large ocean-going iron steamship. She was, in fact, the initial incident in the history of the Victorian iron ship and screw-propelling age.

That celebrated engineer then decided on still larger vessels of iron, and, as the result, the celebrated *Great Eastern* was built from his designs in 1852, with a length of 680 feet, a breadth of 83 feet, and average draught of 25 feet. Unfortunately, her propelling power was inadequate to her gigantic proportions, for her engines were nominally but 1,600 horse-power, and indicated only 4,000 horse-power. Had it been commensurate with her size his great model would have been earlier followed, and would sooner have changed the system of ocean navigation. Subsequent improvements in the screw propeller and in steam marine engines, together with increased over-ocean traffic, prepared the way for the adoption of large vessels, and those of our great steamship lines are, therefore, now but little inferior in size to his *Great Eastern.*

We are also largely indebted to Brunel for the introduction of the screw as a propelling power for large vessels, for his *Great Britain* differed from her ocean-going predecessors by being fitted with it. This propeller was six-bladed, and was of a widely different form to that now in use—its pitch being about 25 feet and its diameter 15½ feet. The rotatory motion was communicated to it from the crank shaft through four endless chains!

Up till the date of her construction the paddle-wheel was the only propelling power used for large vessels. Its disadvantages were obvious to the most superficial observer. There was first its great size and unwieldiness, and then the width which it added to the true beam of a ship. Its vulnerability, when applied to war-ships, was another amongst several other drawbacks to its use. And yet, in face of these objections, it was difficult to overcome the prejudices against the substitution for it of the screw, as the following concise glance at the history of its introduction will not only show but also will illustrate the ingenuity which has brought it to its present state of perfection.

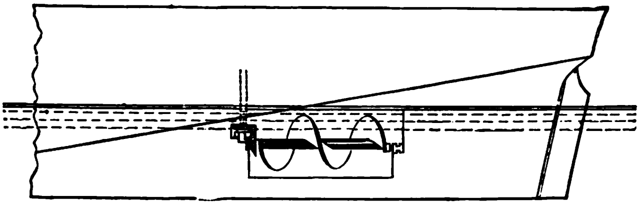


Side Elevation of *Great Britain's* Engine, made by Messrs. Penn.

The earliest record we have of the screw propeller is that its use was proposed by James Watt and by that well-known engineer, Joseph Bramah, who took out a patent for its application to the propulsion of vessels in 1785. Several other similar patents were taken out about the same time.

In 1804, or in the interval between Symington's third successful experiment and Fulton's enterprise in the construction of the *Clermont*, a Mr. Stevens, of Hoboken, steamed from there to New York in a small boat fitted with a screw propeller moved by a rotatory engine. This is the first instance we can find recorded of its practical application to the propulsion of vessels in 1785. It was not till 1836, however, that a serious effort was made to apply the screw to navigation, when a Mr. Pettit Smith, an English farmer, and Captain Ericsson, a Swede, made successful experiments with it, and which were ultimately followed up independently, with excellent results, by both inventors.

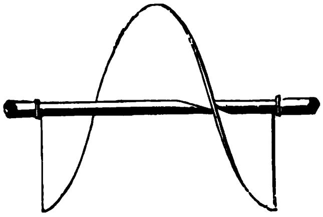
Mr. Smith, who had become much interested in the construction and propulsion of boats, took out a patent for a propeller in May, 1836, "to consist in a sort of screw or worm, made to revolve rapidly under water, in a recess or open space formed in that part of the vessel commonly called the 'dead rising,' or 'deadwood' of the run," as illustrated in the following woodcut:

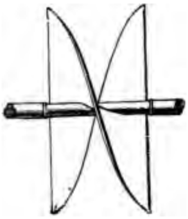


This was the first form of a screw propeller, consisting, as will be noticed, of two complete convolutions of the thread on the shaft.

A boat fitted with this form of screw was tried on the Paddington Canal in 1837, and by accident half of the length of the thread, or one convolution, was broken off. Instead, however, of reducing, it increased the speed of the boat. A new screw, with a single convolution, was then used, instead of the original one with two convolutions, which gave comparatively good results. The next step in advance was the construction by Mr. Smith and his friends of the historic *Archimedes*, the first sea-going steamer ever fitted with a screw propeller, which was 237 tons burthen, and was launched in October, 1838. She was propelled by a pair of engines with cylinders of 37 inches diameter, with a stroke of 36 inches, which drove the screw through the medium of gearing. The consequence was that while the engines made 26 revolutions the propeller made 138⅔ revolutions per minute. This vessel made 9·25 knots an hour, or double what was anticipated.

She was at first fitted with a single-threaded screw of one convolution, thus:

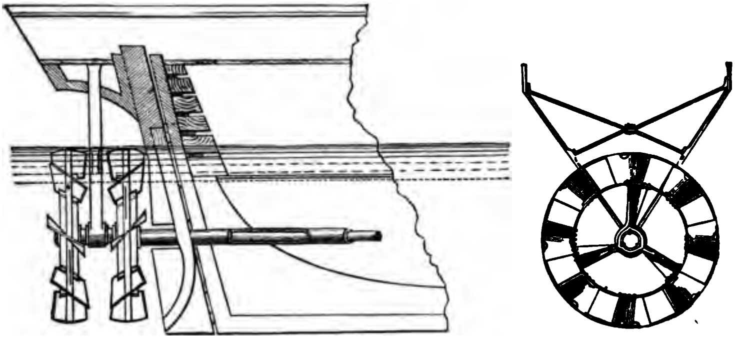




After her trial this was replaced by a screw with two half-threads placed opposite to each other on the shaft, as above.

This second, or double-threaded screw, was the type followed in the majority of screws which subsequently came into use in the British marine. It was subsequently ascertained that something like one-sixth of convolution was sufficient for most purposes. A model of a third propeller on this principle, subsequently fitted to the *Archimedes*, may be seen in the Kensington Museum.

The relative merits of the paddle-wheel and screw were now tested, under Admiralty supervision, in a run from Dover to Calais and back between the *Widgeon*, the fastest paddle-wheel mail packet on the station, and the *Archimedes*, the latter beating the former on the outward trip by nine minutes, and on the return by five and a half minutes, with a beam breeze and full sail.



Ericsson's Screw Propeller.

Captain John Ericsson has, however, a right to a large share of the credit of carrying the screw propeller into successful operation. His patent is dated July 17th, 1836, when he entered into partnership with an English engineer named Braithwaite, for the manufacture of screw propellers.

His propeller consisted of "two thin hoops or short cylinders made to revolve in contrary directions round a common centre, each cylinder moving with a different velocity from the other." Each of them was furnished with a series of short spiral plates, those of each series standing at an angle exactly converse to that given to those of the other series. These cylinders or screws were fitted on the same axis, one in front of the other, as seen in the woodcut, the sternmost screw revolving the quickest, because it acted on water already set in motion by the forward one.

During 1836 Ericsson made frequent experiments with his propeller on a model boat 20 inches long, and in the following year he applied his invention to a vessel 45 feet long by 8 feet wide, and 2 feet 3 inches draught, named the *Francis B. Ogden*, which was tried on the Thames with complete success on April 30th, 1837, when she attained a speed of ten miles an hour. She also towed a schooner of 140 tons seven miles an hour, and on May 25th a Montreal-built barque named the *Toronto*, 360 tons measurement, at the rate of four miles an hour against the tide.

Captain Stockton, of the United States Navy, witnessed these experimental trips, and predicted that the screw would revolutionise naval warfare. In the spirit of that enterprise which so largely characterises our American cousins, he further declared: "I do not want the opinion of your scientific men! What I have seen to-day on the Thames satisfies me!"

As a practical proof of his conviction he immediately gave Ericsson an order for two boats fitted with screws driven by steam. In July, 1838, the *Robert F. Stockton*, also fitted with it, was launched at Birkenhead by Messrs. Laird & Co. Her length was 70 feet, beam 10 feet, and draught 6 feet 9 inches.

The engines of this vessel were in advance of those used by Mr. Smith in the *Archimedes*, for they were direct-acting—that is, the pistons worked directly on the crank-shaft instead of through spur-gearing, as was the case of the latter. Her speed on her trial trip was from eleven to twelve miles an hour.

The *Robert F. Stockton* crossed the Atlantic under sail early in 1839, and was sold in 1840 to the Delaware and Raritan Canal Company, by whom she was employed for several years as a tug-boat, when her name was changed to the *New Jersey*.

Two years later the United States Government fitted up a war vessel named the *Princeton* on Ericsson's plans. The engines were of a very peculiar type, originally designed by James Watt, but for the first time constructed for this vessel. The reason for its adoption was as follows: the great number of revolutions of the screw involved such a high speed as to lead to the fear that the constant reversal of the direction motion might, under the circumstances, knock the engine to pieces. It is now known that with proper construction no fear need be entertained under this head, for direct-acting screw-engines now run at speeds never dreamed of in Ericsson's time.

In 1843 the French Government gave an order to fit a frigate with a propeller on Ericsson's system. The engines were of 220 horse-power, direct-acting, and placed below the water-line, and were the first horizontal screw-engines ever constructed. The speed obtained by this vessel, the *Pomone*, was seven knots an hour, being two knots more than was promised.

Our own naval authorities at first gave Ericsson's as well as Smith's screw-propelling projects the cold shoulder—for they alleged in 1837 that the apparatus being at the stern, vessels fitted with it would not steer. But these *à priori* prejudices were soon corrected by actual experimental demonstrations.

One of these experiments is commemorated by a picture in the Naval Model Room of the Kensington Museum, representing H.M. sloops *Rattler* and *Alecto* towing stern to stern for the purpose of testing the relative power of the screw propeller and the paddle-wheel.

The *Alecto* was fitted with direct-acting engines and the ordinary paddle-wheel. The former measured 888 tons register, and the latter, the *Alecto*, 800 tons. The trial referred to took place on April 3rd, 1845, in the North Sea, and resulted in a victory for the screw over the paddle-wheel.

Encouraged by the success of the *Archimedes*, the Admiralty introduced the screw propeller into the Royal Navy, and constructed the *Rattler* with a view to its adoption. She was launched in 1841, according to Messrs. Maudslay, Sons, & Field's list of steamers engined by them, and then fitted by that firm with double cylinder engines and Smith's screw propeller.

Previous, however, to this trial, various experiments were carried out on the *Rattler* in order to ascertain the best proportions for the propeller, which resulted in a considerable diminution of the size of thread used for the blades. The *Rattler* on this occasion was fitted with a screw differing in some important respects from that of Smith's, and introduced to the attention of the Admiralty by Mr. Bennett Woodcroft in 1843. His experiments, which were coeval with those of Smith and Ericsson, resulted in the alteration of the rate of pitch in some of the blades, in order that the spiral formed by them should give an increasing pitch in the sternwards direction.

The object of this idea was to start the water into motion by that part of the blade which had the least rate of pitch, and, as it increased in velocity, that it should be met by those portions of the screw spiral which twisted more rapidly. In order to meet the varying circumstances of voyage, he further proposed so to attach the blades to the boss that the angle of inclination with the former to the latter might be altered at will from the inside of the vessel.

In 1843 the Admiralty informed Mr. Woodcroft that if he would make a screw at his own cost they would try it on H.M.S. *Rattler.* This was done, and after a trial trip on the 18th of March, 1844, "My Lords" objected to the screw because "*it had to be driven so fast* before it could be got to propel the vessel"; and returned it to the patentee. In 1845 Woodcroft made another screw with an increased pitch, and consequently with what is technically called "less slip." This was accepted by the Admiralty, paid for, and fitted to the *Rattler.* It was the first varying pitch screw propeller ever made; and in 1846 a full-sized screw on this principle was fitted to H.M.S. *Dwarf.*

Amongst the models of these early screw propellers in the South Kensington Museum are those of Mr. James Lowe, whose original designs were patented in March, 1838, one of which was fitted to the *Great Britain.*

In its earlier and, as may be said, undeveloped state, the screw, as a propeller for large ocean steamers, was looked upon merely as an auxiliary to their canvas, either to enable them to proceed on their voyage when there was no wind, or to accelerate their speed when it was light, or to enable them, close-hauled, to go two points higher when contending with it when ahead. The title of such vessels then was — the Auxiliary Screw Steamship *So-and-so.*

The *Sarah Sands,* built at Liverpool and running between that port and New York, in 1848, was so designated. She was a full-rigged iron ship, fitted with a screw. In shape she had a less breadth of beam than was usual for her length; and this was largely the model of the early auxiliary screw steamships. To make up for this narrowness she had a great depth. The consequence was that in a beam sea she rolled so heavily that even the sailors could not walk along her decks without the use of man-ropes. The author sailed in her in April of that year from Liverpool to New York, when she was eighteen days from port to port.

CHAPTER VI.

The founders and founding of the Cunard Company, and review of the first fifteen years of its history.

UNTIL the year 1838 the Lords Commissioners of the Admiralty, through whom the contracts for the transport of American and other over-sea mails were arranged, contented themselves with the uncertain service of sailing ships, or "coffin brigs," as they were at the time contemptuously designated. The success, however, of Transatlantic steam navigation raised such a strong public opinion in favour of its being used for the more rapid and certain conveyance of these mails, as to compel its adoption by the Government. A circular was therefore issued, in 1839, by the Comptroller of "Steam Machinery and Packet Service," asking for tenders for such a service.

Not a steamship owner in the United Kingdom, however, responded to this invitation. Even the late Sir George Burns, after duly considering the matter, informed the Comptroller that "he did not see his way clear to enter upon such a large undertaking as the proposal of the Government involved." "His hands," he further stated, "were full, and he therefore determined to let the Atlantic steamship navigation business alone"!

But it was not destined to be let alone, for away at Halifax, Nova Scotia, it was taken up by a colonist whose attention had been directed to the importance of the project for some time. This was the late Sir Samuel Cunard, a member of a well-to-do Quaker family which had emigrated from Wales to America early in the seventeenth century, and settled in Philadelphia. Being Royalists, the family emigrated from the United States, when they declared their independence, to Halifax, N.S., where he was born in 1788. After serving with much distinction in a merchant's office he accepted a partnership in a leading shipowning firm of Boston, Massachusetts.

While still a young man he proposed to the Admiralty, in 1815, to undertake at his own risk the conveyance of mails between Boston, Newfoundland, and Bermuda, and carried out his scheme most satisfactorily to the British Government.

As early as 1830 the idea of ocean steam lines occurred to him, and in 1833 we find him connected with the company which built the *Royal William* that year at Quebec. He firmly believed that steamers, properly built and manned, might start and arrive at their destination with a punctuality almost equal to that of railway trains. In fact, the steamship was to him a railway train without double metal rails. The latter, he often jokingly said, were only required on "the ugly, uneven land," with its excrescences of high hills and deep valleys; but that the steam marine locomotive on "the beautiful level sea" did not need them.

One of the circulars issued by the Admiralty for tenders for a Transatlantic mail service having fallen into his hands, he immediately resolved to avail himself of the favourable opportunity it afforded him to carry out his long-cherished project. As capital was needed to accomplish his object, and having failed to interest the Halifax or Boston merchants in the scheme, he came to England in order to secure it.

Mr. Cunard acted as agent in Halifax for the East India Company, and on his arrival in London he put himself in communication with its secretary, Mr. Melvill (brother, by the way, to the Rev. H. Melvill, the celebrated Golden Lecturer), who introduced him to Mr. Robert Napier, by whom he was brought into contact with the late Sir George Burns. The latter in his interview with Mr. Cunard, in recalling this important epoch in his life, said that, "It was not long before we began to see some daylight through the scheme, and I entertained the proposal cordially, and invited Mr. Cunard to dine with me." Mr. McIver, to whom he broached the scheme, at first went dead against it, and after dinner he advised that Mr. Cunard should be told "that the thing would not suit them." They breakfasted with Mr. Cunard next morning at Mr. Robert Napier's house, and went further into the details of the scheme, with the result that within a few days the requisite capital of £270,000 was raised, and an eligible offer made to the Admiralty for the conveyance of Her Majesty's mails once a fortnight between Liverpool, Halifax, and Boston. The tender was accepted, and a contract was concluded for seven years between the Government and the newly-formed Company, and signed on its behalf by Samuel Cunard, George Burns, and David McIver. The payment for the services of carrying the mail was fixed on a sliding scale according to the amount of postal matter carried by the steamers. The actual receipts under this first contract amounted to £3,295 the round voyage. There were, however, certain restrictions in this original contract about allowing the vessels to be used in time of war, and carrying naval officers on board each vessel, and other things which caused the Company a great deal of trouble and expense. It therefore agreed to take less money if these restrictions were removed, and a second contract was entered into for £70,000 a year with no naval officers on board. Sir George Burns never liked the term subsidy, and insisted that the payment received from the Government was freight paid for carriage of letters—that is, for work done.

The Company in making their rules for the management of their fleet kept the one great object of safety in view. To their honour be it recorded that profit was placed second to that object, and from its establishment to the present time this great characteristic has been maintained. Mark Twain humorously remarked in after years in view of the precautions of the Company that "he felt himself rather safer on board a Cunarder than he did upon land."

The first four ships built by the British and North American Royal Mail Steam Packet Company, as the Cunard Company was then formally called, were the *Britannia*, *Acadia*, *Caledonia*, and *Columbia*. They were wooden paddle-wheel vessels, built on the Clyde in 1840, and supplied with common side-lever engines by Robert Napier.

The *Britannia*, the first built and placed on the line, measured 207 feet long, 34 feet 4 inches broad, and 22 feet 6 inches deep, with a tonnage of 1,154, and an indicated horse-power of 740. Her cargo capacity was 225 tons, and she had accommodation for 115 first and second-class cabin passengers, but no steerage. The other ships were almost identical with the *Britannia*. Their average speed was 8½ knots an hour on a coal consumption of 38 tons daily.

The pioneer ship left the Mersey on July 4th, 1840, when it was calculated she would reach Boston in fourteen and a half days, but she anticipated this by four hours. Mr. Cunard went out in her, and during his stay of twenty-four hours in Boston he received no less than 1,873 invitations to dinner! The arrival of the *Britannia* was marked by an unprecedented display of bunting and cheering, and by a banquet given by the Bostonians in honour of the event, and the enthusiasm it excited found expression in very complimentary speeches. That their goodwill did not then entirely evaporate is shown by the following incident. The winter of 1840-41 set in early and with great severity, and the *Britannia* was frozen up in Boston harbour. As there were grounds for fearing that she might be imprisoned in the ice for many months the Bostonians, at their own expense, and with the aid of thousands of volunteers, cut a channel through it of more than seven miles in length, to set the steamer free.

Such, then, was the origin of the Cunard Company, and with it the commencement of a leading epoch in the history of Atlantic steam navigation.

Other steamers followed in quick succession, in all of which were introduced the newest and most reliable advances in scientific engineering. Thus, in 1844, the *Cambria* and *Hibernia*, of 500 horse-power each and of 1,422 tons, with an average speed of 9¼ knots, were built. In 1848 the *America*, *Niagara*, *Europa*, and *Canada*, each of about 1,820 tons and 680 horse-power, with an average speed of 10½ knots, were also added to the Cunard fleet.

In 1847 the Americans, realising the fact that their most valuable maritime commerce was passing from them to the new British Transatlantic steamships, established a line of their own, to run from New York to Southampton. Their first ship, the *Washington*, started on the same day that the *Britannia* sailed from Liverpool to New York. This was the first race between American and British steamers, and was won by the latter by two full days!

In 1850 the British Government made a contract with the Cunard Company for the conveyance of mails between

Halifax, New York, and Bermuda, and another for St. John's, N.B., to start twenty-four hours after the arrival at the first-named port of the packet from Liverpool. In 1851 another contract was concluded with Mr. Cunard for a monthly conveyance of mails between Bermuda and St. Thomas, in order to connect the West Indies with the United States and the North American Provinces. The Americans saw, with natural dissatisfaction, that ocean mails along their southern coast had been undertaken by foreign carriers, and that the Cunard line, under British contracts, was the only medium of regular steam navigation between them and Europe. They therefore resolved to make their postal arrangements altogether independent of foreign and rival agencies, and advantageously subsidised a line of steamers between New York and Chagres viâ New Orleans, and secured the power to transport of their mails for Mexico, South America, and their possessions on the Pacific, which, on account of the gold discoveries in California, had become of great importance. Thus encouraged, they concluded that similar success would attend the establishment of a line of steamships of their own between New York and Liverpool. The project was taken up by Mr. E. K. Collins, of New York, and other Americans, who established a line of splendid steamers, with the avowed object of driving the Cunarders off the Atlantic. They were named the *Arctic*, *Baltic*, *Atlantic*, and *Pacific*, and were equal, at the time, if not superior, to any vessels afloat constructed of wood.

The Collins Company asked from the United States Government a monopoly of the Atlantic steamship trade and a subsidy, on the allegation in their memorial that the rival English line was sustained to a very great extent by the English Government.

In response to this appeal the Company obtained a subsidy equivalent to £178,750 sterling per annum. The United States Government, however, made it a *sine quâ non* that their vessels should be sailed at a greatly increased rate of speed.

The Collins Line began to run in 1850, and the competition between it and the Cunard Line excited great interest on both sides of the Atlantic at the time. Records were kept and published of the length of the voyages of their respective vessels, and large sums of money changed hands in betting on the result of each trip.

The Cunarders, although beaten by their rivals in respect of the time in these voyages, gained steadily in the estimation of the travelling public both on the score of comfort and the sense of safety.

The Cunard Company, however, resolved not to be beaten, decided upon producing a fleet of steamers defying all competitors both in speed and comfort.

While the world was loudly applauding the triumph of America in the "great ocean race," as it was incorrectly called, over Britain, Mr. Charles MacIver wrote to Mr. Cunard that:

"The Collins Company are pretty much in the situation of finding that breaking our windows with sovereigns, though very fine fun, is too costly to keep up."

And this prediction was soon verified by events.

For four years the Collins Line encountered no serious accidents, but in 1854 it met with a series of disasters.

In September of that year the *Arctic* was struck by the French vessel *Vesta* off Cape Race, and only 46 out of 268 souls on board were saved. Amongst the lost were the wife, son, and daughter of Mr. Collins.

The *Pacific*, another of the line, left Liverpool on June 23rd, 1856, and was never afterwards heard of.

Capital was, however, found to replace the lost vessels; but before they were ready for service the new Cunard fleet was at sea defying all competition. The average speed of its new ships in 1856 eclipsed not only that of the Collins Line, but also that of all the other lines engaged in the Transatlantic trade.

Amongst these was the *Persia*, built and engined in 1855 by Messrs. Robert Napier & Sons, of Glasgow. She was described by the Press as "the largest steamer, both in capacity of hull and steam-power, that has yet been built." Amongst the 50,000 spectators at her launch, there were, it was said, many who had witnessed the launch of Mr. Bell's *Comet* in 1812, and, as we have seen, the first vessel propelled by steam in British waters.

The *Persia* was also represented as superior in size to any steamship afloat, and exceeding in tonnage, length, strength, and power, either the *Great Britain* or the *Himalaya* by 1,200 tons, "the internal capacity of the largest of the splendid Cunard Liners." And yet what was she comparatively with the latest additions to that fleet? Her length from figure-head to taffrail was but 380 feet, and that of her keel but 360 feet; her breadth of beam was 45 feet, or over all—that is, including her paddle-boxes—71 feet; her hold was 32 feet deep, and she measured 3,870 registered tons. The engines of the *Persia* were 900 horse-power nominal, but could be worked up to 1,200 horse-power. She had eight boilers and two funnels and seven watertight compartments, and was the first of the Cunard ships built of iron. She had accommodation for 300 passengers, and when fully loaded drew 22 feet.

A thousand ladies and gentlemen were at the lunch given at her launch, and the Provost, Mr. Marshall, who acted as chairman on the occasion, in proposing the health of Mr.

Robert Napier and his son, spoke of the *Persia* as the "greatest triumph of Art that ever had been seen," and declared that the men who had performed the work of her construction deserved the applause of every citizen of Glasgow.

The *Persia* was the twenty-seventh steamer built by the Cunard Company, and the following comparison with the first one built in 1840 shows the progress made in the construction of ocean steamers:

	Britannia.	*Persia.*
Coal consumed in round voyage	570 tons	1,400 tons.
Cargo capacity	224 "	750 "
Indicated horse-power	710	3,600
Pressure to the square inch	9 lb.	33 lb.
Speed	8·5 knots	13·1 knots.

In 1858 the Collins Line was competing with the Cunard Company at such a ruinous rate of expenditure that it soon collapsed, and the American Government determined not to aid any future similar company from the public revenue. Henceforward until last year, in the conditional transfer of the Inman Line of steamers to the American flag, the steamship trade of the North Atlantic has been for many years almost a British monopoly.

CHAPTER VII.

Difficulties and obstacles in the way of a proposed ocean railway communication with the far East, how successfully met and overcome.

We must now, in the course of our narrative, ask our readers to go back with us to the period when the successful voyage of the Canadian *Royal William*, and those of the *Sirius* and *Great Western*, proved the feasibility of connecting America with Europe by steam, and proceed to call their attention to the contemporaneous efforts made to secure a similar service between the United Kingdom and the far East. The incidents which marked the establishment of the latter are, we venture to say, of equal interest with those of the former. In fact, when the difficulties are taken into account which had to be overcome before our present steam communication with India, China, Japan, and Australasia was successfully established, we may regard it as one of the most successful and brilliant manifestations of that enterprise, skill, and perseverance which has built for us our mighty empire.

Our communication with the far East had been over the route first established by Vasco da Gama round the Cape of Good Hope, and by sailing vessels; the distance from London to Bombay being 10,719 nautical miles, and the average passage 100 days. The distance to Shanghai by this route was 13,805 nautical miles, and the voyage from London averaged 130 days; and to Yokohama, 692 miles farther, 137 days.

Owing to their limited carrying capacity in those early days of ocean steaming, and the want of coaling stations along the route, the distances which would thus have to be traversed by steamers between London and these eastern ports by the Cape of Good Hope were obstacles which precluded the practicability of their profitable employment in such a service. One steamer had already attempted this long voyage, but as we have already seen, did not repeat the experiment.

The overland route, as it is called, from the Mediterranean across the Isthmus, and through the Red Sea to India, is older than the days in which the Queen of Sheba came to visit Solomon.

To Captain Waghorn, however, belongs the honour of having inaugurated it in modern times. As the result of its adoption, the East India Company, about 1839, in order to avail itself of the advantages it offered over the route round the Cape, began to run steam vessels from Bombay through the Red Sea to Suez, but this service was not found to be commensurate with the public wants and aspirations. In the discussion of the subject to which this feeling gave rise, British and Indian statesmen earnestly called attention to the great benefits likely to accrue from a more rapid and regular steam navigation between the United Kingdom and the East. Many enterprises were projected to meet the demand, but it was not actually effected until the Peninsular Company undertook to carry it out. As in the case of Postal steam communication with America, this Company, amongst other considerations, were enabled by the growing policy of the Government to establish an over-sea mail service by steam in place of the existing slow one by sailing packet.

Over half a century ago Lisbon was regarded by Englishmen as one of the most important places in the Peninsula.

The mails were conveyed there from Falmouth by sailing packets, departing when "wind and weather" permitted. Not unfrequently they were as long as three weeks on the way, or longer than is now required to transmit mails from London to Calcutta. The mails to Gibraltar were then conveyed only once a month by Government steamers, neither remarkable for the speed nor regularity of their voyages.

In 1835 Messrs. Willcox & Anderson, a firm of London merchants and shipbrokers, began running steamers to the chief Peninsular ports. This was regarded as a somewhat bold experiment, and was not at first attended with encouraging financial success. But the firm persevered in their enterprise, and eventually submitted to the Government a plan for the establishment of a mail service by their steamers in place of the Lisbon packets and the Gibraltar Government steamers, with a considerable saving to the Exchequer.

The Government received this proposal coldly at first, and continued to transmit the mails by sailing packets to and from Lisbon, but under the pressure of public opinion, roused by the regularity of Messrs Willcox & Anderson's steamers, asked the firm to re-submit plans for the conveyance of the mails. These were, after a strict examination, approved, and the terms asked considered reasonable. But before they were accepted, acting upon the information it had thus acquired, the Government issued invitations for tenders for the service, to which two responses only were received—one from the above firm and another from parties describing themselves as the "British and Foreign Company." The latter not being able to give satisfactory proof of their means and capacity to carry out the service, the contract was given to Messrs. Willcox & Anderson, who then, in conjunction with Captain Richard Bourne, R.N., founded the Peninsular Company to carry it out. The date of this contract was August 22nd, 1837, and the subsidy it secured to the Company was £29,600 per annum for a monthly service from Falmouth to Vigo, Oporto, Lisbon, Cadiz, and Gibraltar.

The satisfactory manner in which this contract was carried out proved to the Admiralty, the Government department then and for many years subsequently charged with the supervision of mail contracts, that such a service could be more efficiently and economically carried out by private enterprise than by ships of the Royal Navy. It may also be said to have subsequently opened up the way for the extension of the operations to the far East, and also for the contracts for the conveyance of mails to the West Indies by the Royal Mail Company, and shortly afterwards to North America by the Cunard Company.

The next important incident in the operations of the Peninsular Company was the extension of their service from Gibraltar to Malta and Alexandria. From the former place the mails were at first conveyed onwards by Government steamers of limited tonnage and power to the last-named place; but the transmission by this process occupied from three to four weeks, and the Indian mails carried by these steamers to Alexandria, and thence overland to Suez to meet the East India Company's steamers, rarely reached Bombay under two months. An attempt was made to accelerate this service by sending the mail overland to Marseilles and thence by steamer to Alexandria. But it did not dovetail satisfactorily with the long sea route from Suez, and there was a fear of the Indian correspondence being tampered with on its way through France. The Government of the day resolved, therefore, to have a service by powerful steamers between England and Alexandria, and a contract was entered into in 1839, with the Peninsular

Company with that object. The annual subsidy then secured to the Company was £34,200, and it provided for vessels of 450 horse-power. Two new vessels, the *Oriental* and *Great Liverpool*, of 1,600 tons and 450 horse-power each, were at once employed on the line. The bargain was a good one for the Government as well as favourable to the public, for the inadequate Government service it superseded had been costing not less than £44,000 per annum, including the depreciation and sea risk of the vessels employed.

The next extension of this line of ocean railway to the East was the undertaking by the Peninsular Company of the inadequate and regular service hitherto carried on by the steamers of the East India Company through the Red Sea to Suez. They considered that the enterprise was not only a public necessity which ought to be supplied, but naturally concluded, from a business standpoint, that the new service would materially assist their Mediterranean line. They therefore applied for and obtained a Charter of Incorporation for establishing steam communication with India, under the title of the Peninsular and Oriental Steam Navigation Company; it was dated December, 1840, and granted on condition that the Company should carry out the service it authorised within two years. No subsidy was promised beyond an undertaking from the East India Company to pay premiums, not to exceed £20,000 per annum, on a certain number of voyages accomplished.

The directors immediately built the steamers *Hindostan*, 2,017 tons burthen and 520 horse-power, and the *Bentinck*, 1,974 tons and 520 horse-power, and purchased from another company the *Precursor*, 1,817 tons and 500 horse-power, for the service. They had also special steamers constructed for Nile work, in order to improve the transit through Egypt, commenced by Waghorn some years previously. The first steamer was despatched by the Company to India on the 24th September, 1842. Her departure on that date for Calcutta was of such great national importance that it may be regarded as marking an epoch in the history of steam navigation in its extension eastward, as did that of the *Britannia* two years previously in its extension westward.

Bombay.

The service thus established was between Suez, Aden, Ceylon, Madras, and Calcutta, for the East India Company retained that to Bombay, although the P. and O. Company made a proposal to the Government to establish a monthly line between it and Suez. The non-acceptance of this proposal, combined with the inadequacy of the East India Company's premiums for the voyages between Suez and Calcutta, in the present undeveloped state of its traffic and the necessarily enormous working expenses of the line, brought on a serious crisis for the P. and O. Company. The Government then decided, in concert with the East India Company, to establish a regular monthly service, not only to Ceylon, Madras, and Calcutta, but with extensions to Hong Kong and Shanghai in the interests of the India and China trade. A contract was made with the Company for this important extension, with an annual subvention of £160,000.

The Indian portion of this new and improved service was commenced on January 1st, 1845, and nine vessels were simultaneously constructed during that year by the Company, in addition to the vessels mentioned as having already been despatched to the East. They also established, for commercial purposes, lines of steamers on the Italian coast, and to Greece and the Black Sea.

As in the case of the initiation of steam communication with America, the P. and O. Company met with financial difficulties in establishing this long line of communication from Southampton to Calcutta, and from Ceylon to Hong Kong. Capitalists were slow in their investment of money in the scheme, and the Government showed great unwillingness to sustain it by subsidies for mail purposes, preferring the system of conveyance by Government vessels. There was also the opposition to be overcome of those who considered that they had vested interests in the carrying trade of the East because they had invested a large amount of capital in sailing ships. In the present day, when the ownership of steamers trading with the most distant ports of the world is so common, it is not easy to recognise the serious obstacles which interfered with the carrying out of an undertaking such as that which the P. and O. Company had so successfully carried out. Energy and administrative skill of no ordinary kind was also demanded before these new lines could be brought into good working order.

For example, along the whole route from Suez to Calcutta and Hong Kong, 4,800 and 7,380 nautical miles respectively distant from Suez, every ton of coals for the steamers had to be sent out by sailing ships from England. There were no markets at many of the ports for provisions, in our sense of the term, and practically no hotel accommodation on the route. Only those who have had experience in similar work can understand the difficulties which had to be overcome in storing the comparatively large steamers of the Company, and which did not embarrass the founders of the Transatlantic lines.

Perhaps, however, the most arduous task of all was the organisation and working of the transit overland of the mails, merchandise, and passengers from Alexandria to Suez — a service necessarily included in the establishment of the P. and O. Company's Eastern lines.

Captain Waghorn, who had revived and in fact inaugurated this overland route, had only roughly demonstrated, as it were, the practicability of conveying mails and passengers through Egypt, the appliances on an adequate scale for traffic purposes across the isthmus being non-existent.

It may enhance the enjoyment of those who are now either conveyed all the way by steamer to the East through the Suez Canal, or after a railway journey to Brindisi and a sea voyage of three days to Alexandria are thence whirled across the isthmus by the "iron horse," to recall the former pre-railway days of accomplishing the latter part of the journey to India. They will admit that the great discomforts to which it subjected passengers largely counterbalanced its picturesqueness.

After landing at Alexandria the first part of the transit, viz., forty-eight miles, to Atfeh, by the Mahmoudieh Canal, was accomplished in a large canal-boat towed at the rate of five miles an hour by a steam tug. The passengers were then transhipped into Nile steamers and conveyed 120 miles up the river to Cairo in about sixteen hours. There a delay of a night, and of sometimes two or three days, was spent at "Shepherd's Hotel" and in seeing the sights of the city and its interesting surroundings.

From Cairo the route led for ninety miles across the desert, and the journey was made in two-wheeled omnibuses, holding six persons each and drawn by four mules or horses. The road being merely a track in the sand, not easily distinguishable at night, the horses often strayed from it and stumbled into a bank of sand, where they floundered until extricated by horses brought from the nearest station—some four or five miles distant.

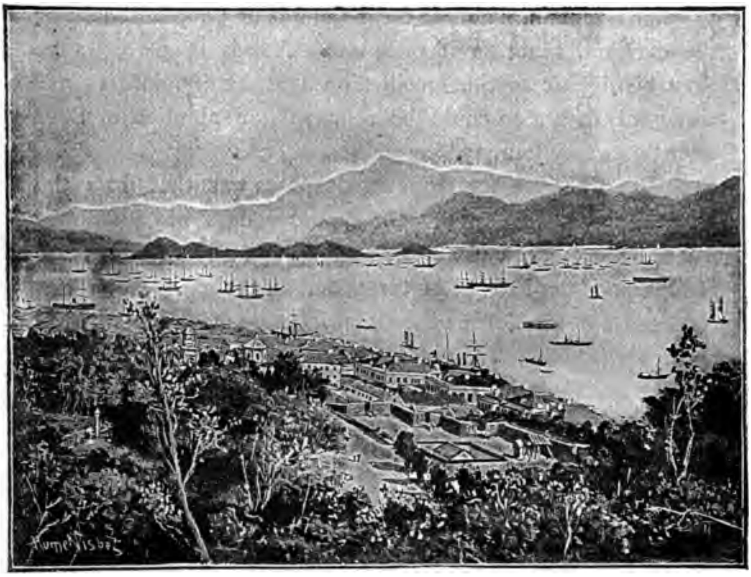
Sir Thomas Sutherland, Chairman of the P. and O. Company, thus describes this part of the transit across the isthmus:

"A journey of some eighteen hours under these circumstances could hardly be called enjoyable, even when its tedium was relieved by drinking innumerable cups of coffee at the various stations where the horses were changed. Still, the experience was one which impressed the imagination in no ordinary degree. A moonlight journey was most striking. The seeming boundless expanse, the silence only broken by the voice of the driver and the muffled sounds of the horses' feet; the caravans of camels loaded with mails and baggage passing along with silent tread; the whitened bones of countless camels, which had died in harness, glistening in the moonlight; then the sudden daybreak; the solitary mounted Bedouin family mounted aloft on their desert ships; the mirage, so wonderful when first seen; these and other impressions remain indelible on the minds of people who knew the overland route as it once was. Nor is it, perhaps, the least vivid part of the recollection that hardly more than a teacupful of water could be obtained for ablution at Suez after this weary journey."

The only water for drinking purposes was that from the Nile, and was unfiltered. Ice in those days was unknown, and the bottled beer, usually fallen back upon by a thirsty man, tasted as if it had been three-fourths mulled. Sleep was rendered unrefreshing by the attacks of the mosquito and the not less irritating assaults of the ever-present and insatiate flea.

The transport of cargo across the isthmus was nearly as difficult as that of passengers, particularly between Cairo and Suez, as every package had to be carried by camels. Many hundreds of these animals were employed in this service. Water also had to be conveyed by them to the several desert stations and to Suez. But more strange still, the very coal for the steamers in the Red Sea had to be carried across the isthmus in the same manner. In fact, it was found cheaper thus to send it from Alexandria across the desert than round the Cape by sailing vessel to Suez. It is not singular, therefore, that the directors of the P. and O. Company were the first to urge on the Pasha of Egypt the necessity of constructing a railway across the isthmus, the completion of which, in 1859, changed the old system of transit across it to that with which the travelling public has since become familiar.

The success of the Indian mail service led the public of Australia anxiously to desire the same advantageous communication with the mother country. As early as 1847, and before the gold excitement, the P. and O. Company laid before the Government a series of proposals for establishing steam communication with the Colonies, but they remained unnoticed. A charter of incorporation was in the meantime granted by the Board of Trade to the India and Australia Company for the purpose. This new Company, however, in a comparatively short time became bankrupt.


Hong Kong Harbour.

In 1851, when its first contract with the Government for a monthly line to India and China terminated, the P. and O.

Company's tender for a full fortnightly service, together with an express one in connection with it from Marseilles to Malta, and from Singapore to Sydney, was accepted. In 1854 it took over from the East India Company the mail service between Suez and Bombay, which had cost the country annually £120,000, with a subsidy of only £24,700. In 1858 it entered into a new and special contract with the Admiralty for the conveyance of mails to the Australian Colonies, viâ Mauritius, but this route not proving satisfactory, the itinerary of the line was changed in 1861 so as to proceed by Ceylon.

A Parliamentary Committee about this period recommended that while the future service to China should remain to be fortnightly, including one to Japan, that to India should be made weekly viâ Bombay, and that the departures and arrivals of the mails should be so regulated that letters should be delivered in London on Monday and despatched on Friday. The only substantial tender for this service was sent in by the P. and O. Company, which asked £500,000 for this new and extended service. It subsequently agreed to accept £100,000 less, on condition of the contract being made for twelve instead of six years, and with the proviso that if the Company's profits fell below six per cent. at any time, the Government should make up the deficiency to the extent of the above reduction from its original demand. On the other hand, if the profits exceeded eight per cent. the excess was to be divided with the Government in a certain ratio.

The first year's working of the new contract proved that the whole £500,000 was required to enable the Company to pay six per cent., owing to the depression of trade and the enhanced cost of laying down coals in Eastern ports on account of the Abyssinian Expedition. The Company claimed, therefore, the full amount, which the Government refused until it had examined its books. It appeared that the contract did not clearly prescribe that the profits of the Company as underwriters should be excluded from the reckoning with the Post Office, nor did it define the amount of the sinking fund or depreciation account and the Department. The dispute which ensued was, however, amicably settled by a compromise by which the Company agreed to accept £450,000, and relieve the Government from further obligation as well as from participation in profits.

The P. and O. Company's affairs went on smoothly for some years, for they were in possession of the exclusive trade with the far East. But the opening of the Suez Canal in 1869 disturbed this tranquillity. The flood of tonnage which poured through it soon reduced the revenue derived from a freight and passenger tariff fixed to meet the exceptional expenses of the overland route, to which it was confined by its mail contract with the Government. The Post Office at first utterly opposed the use of the Canal, but subsequently reluctantly offered to allow the Company to do so in consideration of its accelerating the mails twenty-four hours to Bombay and China, and forty-one hours to Australia, and a reduction of £30,000. This offer was refused by the directors, who proceeded to fight the Government by sending their steamers through the Canal and picking up at Suez the mails sent overland from Alexandria, a proceeding which the Post Office authorities had no power to prevent. This produced a state of tension between the contracting parties, which after a two years' struggle was ended by the Company being allowed to use the Canal in consideration of its relinquishing £20,000 of its annual subsidy.

Two years before the termination of its last contract tenders were invited from the public for the Indian and

China service, with a further increase of speed, which was again awarded to the P. and O. Company on the merits of its offer. It was arranged under the contract then entered into that, in consideration of the terms offered, the Suez Canal should be made the exclusive route for the mails, and that the transhipments and quarantine drawback should become a thing of the past. This contract was made in 1887, and provided for an annual subsidy to the Company of £265,000, or £100,000 less than that under the previous one. In ten years, therefore, the Company had reduced the cost of the Indian and China mail services no less than £175,000 per annum.

Reviewing the progress made by the P. and O. Company since its initiation, and recognising its position to-day amongst our ocean railways, admiration must be expressed for the great ability, persevering courage, and business capacity of the managing directors who, in its early history, laid the foundation of its public utility and successful career. These were Messrs. Brodie McGhie Willcox, M.P., Arthur Anderson, M.P., and James Allan. That it has been of great public utility must be acknowledged. The economy it has effected since 1873 under the mail service with the East has amounted to the annual sum of £230,000, while the Australian service has been doubled.

The general improvement, as well as every succeeding one, in the character of the work is also deserving of mention here. For example, the contract time allowed for the transit of the Eastern mails in 1873 from London and including the Continental transit, and at present are as follows :

	1873.	1893.
Indian Mails (Bombay)	23 days	16½ days.
China ,, (Shanghai)	45½ ,,	37½ ,,
Australian Mails (Melbourne)	48 ,,	35½ ,,

The punctuality with which the contract time has been kept is also remarkable, when it is considered that the transit of the combined Indian, China, and Australian mails represents a mileage of about 21,000 nautical miles. Out of 468 mail deliveries from 1887 to 1890, only seven instances occurred in which the mails were even an hour late. On the other hand, of 457 mails delivered, nearly all of them were in advance of contract time.

It is also interesting to compare as follows the goods and passenger rates before the era of the Suez Canal in 1869 with those now in force:

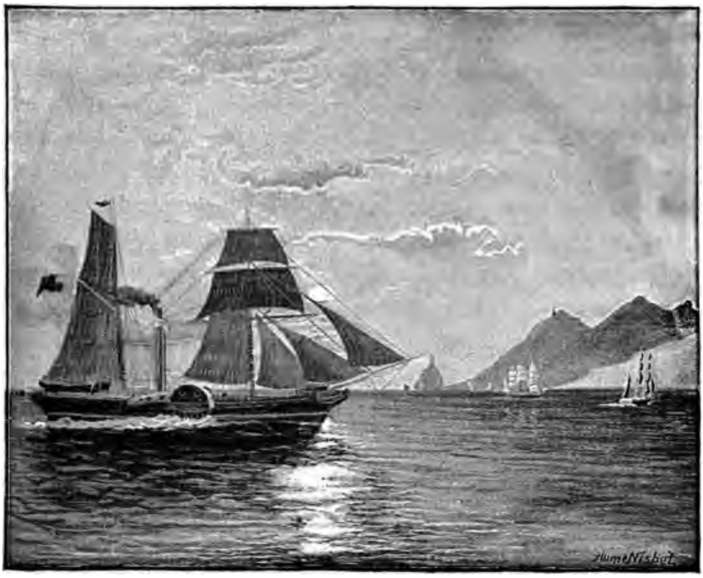
	Bombay.	Calcutta.	China and Australia.	Shanghai and Japan.
1869.				
General Fine Goods . per ton	£12	£20	£30	£33
Provisions and Coarse Goods ... .. ,,	£10	£16	£25	£28
Specie	1½%	1½%	2%	2¼%
1893.				
Cargo according to classification	20*s*. to 30*s*.	20*s*. to 30*s*.	25*s*. to 50*s*	30*s*. to 40*s*.
Specie	½%	½%	½%	½%

The freight on the homeward cargoes in 1869 for silk, silk goods, indigo, and other valuable merchandise, has now declined to a fourth or fifth of what it was then. The passenger tariffs show also comparatively an enormous abatement. The youthful energy and enterprise shown by the P. and O. Company in dealing with the *régime* which existed before the opening of the Suez Canal revolutionised the trade with the East, must be reckoned amongst the wonders of its marvellous history.

The Cunard and other companies may boast of the services rendered to the country in time of war, and have, to a certain extent, the right to do so; but a higher claim for such service may justly be claimed by the P. and O. It has taken part, by its vessels, in every warlike expedition in which we have been engaged for the past fifty years, and in some cases a larger share than others. In the Crimean War, for instance, 2,000 officers, 60,000 men, and 15,000 horses, or a fair contingent of an army, were carried by its vessels. The Government was enabled to despatch, by its aid, no less than 6,000 men to India when the Mutiny broke out. In fact, there are reasons for believing that the early arrival of this force at Bombay prevented the serious consequences which might have followed this great seaport falling into the hands of the mutineers.

Again, when Tokar and Sinkat, in the Eastern Soudan, were threatened by Osman Digma, and the Egyptian troops holding them were in great peril, public opinion compelled the Government of the day to send British troops for their relief. Then, of course, all was hurry and bustle. On the 12th February, 1884, the Admiralty asked the P. and O. Company what they could do towards expediting the transport of two battalions from Cairo to Suakim within the briefest possible time, and in response to this application two of the Company's ships, the *Bokhara* and *Thibet*, then on their way to the East, were, on their arrival a day or two afterwards, despatched through the Canal, and when they arrived at Suez all necessary preparations for the reception of the troops were made. In less than ten hours after their arrival one of them was despatched, and the other in sixteen hours, to Suakim, properly equipped and provisioned, with 1,500 men on board.

In common, as we have seen, with certain other companies engaged in mail service, the P. and O. have entered into arrangements with the Admiralty for the employment of certain vessels in the capacity of cruisers in time of war. Four of them have been fitted with gun platforms and other appliances to fit them for such a service at almost a moment's notice.



The *William Fawcett*, the first P. and O. Steamship, in the Gut of Gibraltar, 1837.

The present fleet of the P. and O. Company comprises over 60 steamships, with a total tonnage of 218,212, varying in size from 2,622 tons to 6,901 tons, and in propelling power from engines of 2,000 up to 10,000 indicated horse-power.

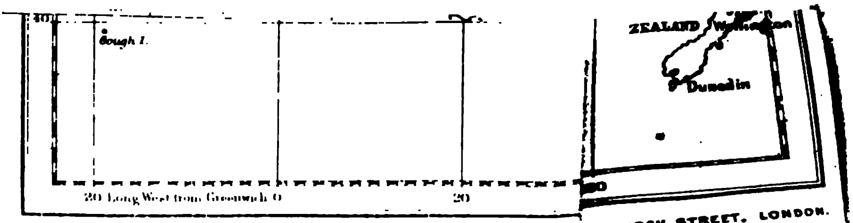
As an illustration of the progress of ocean steam navigation eastwards, we give a woodcut of the *William Fawcett,* the first P. and O. steamer, built in 1829, of 200 tons burden and 60 horse-power, and also of the *Himalaya*, 6,898 tons burden and 10,000 indicated horse-power, built in 1890.

P. and O. S.S. *Himalaya*, built 1892.

All the modern improvements both in models, internal fittings, and in engines, have been adopted and followed by the Company, and their latest built vessels, to the limit of their size, may be favourably compared with any other floating palace hotel on the ocean. The "Book of Regulations" and "Circular" for the "Safe and Efficient Navigation of the Company's Steamships," show provisions for the safety of passengers, vessels, and crews as stringent as human foresight can provide.

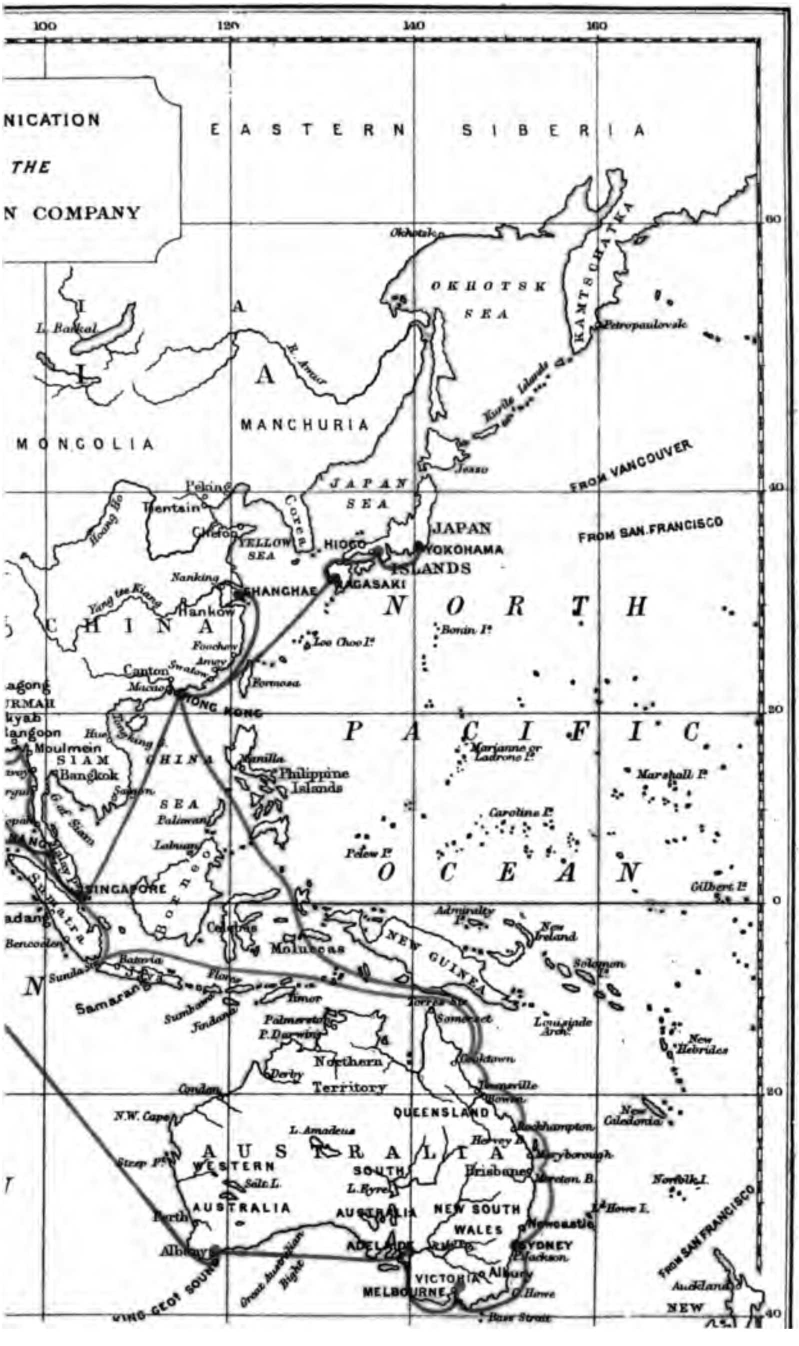
In the days of sailing ships their fixed dates of departure were always announced with the addition of the well-known proviso, "wind and weather permitting." But not so those of the vessels of our regular lines of steamers, for not only is the day fixed for their sailing, but the hour. When the former left port there was great uncertainty as to the date of arrival at their destination. In the case of voyages across the Atlantic they might, after leaving Liverpool, arrive at New York in two or three weeks if wind and weather were favourable, or, if not, perhaps in six weeks. Steamers of lines like the P. and O. have not only fixed times of departure like our railways, but also fixed dates of arrival at intermediate and terminal ports, and, as we have shown, seldom fail to keep them. You can, therefore, run your finger along one of the time-tables of, for example, the P. and O. as down that of one of our railways, and ascertain the day upon which any steamer, after leaving London, will reach the intermediate port in which you may at the moment be interested.

Take, for example, the time-table of the London, Ceylon, and Calcutta. Leaving London on Friday, it informs you that you will arrive at Gibraltar on the following Wednesday, at Naples on the Sunday after, at Port Said on the following Thursday, Aden the next Wednesday, Colombo on Thursday week, Madras three days later, and Calcutta in the same time from the latter port. And the same regularity in departure is chronicled in these tables to the most distant intermediate and



NISSEN & ARNOLD

ENCHURCH STREET, LONDON.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Bangkok
Saigon
G. of Siam
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Palawan
Manilla
Philippine Islands
PACIFIC
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Marshall Is
Caroline Is
Pelew Is
OCEAN
Gilbert Is
Labuan
Borneo
Malay P.
SINGAPORE
Sumatra
Padang
Bencoolen
Sunda St.
Batavia
Java
Samarang
Celebes
Moluccas
Admiralty Is
New Ireland
NEW GUINEA
Solomon Is
Flores
Sumbawa
Timor
Sandalwood
Torres St.
Somerset
Louisiade Arch.
New Hebrides
Palmerston
P. Darwin
Northern Territory
Derby
Cooktown
Townsville
Bowen
Condon
N.W. Cape
QUEENSLAND
Rockhampton
New Caledonia
L. Amadeus
AUSTRALIA
Hervey B.
Maryborough
Steep Pt.
WESTERN AUSTRALIA
Salt L.
SOUTH AUSTRALIA
L. Eyre
Brisbane
Moreton B.
Norfolk I.
Ld. Howe I.
Perth
NEW SOUTH WALES
Newcastle
Albany
ADELAIDE
SYDNEY
P. Jackson
KING GEO. SOUND
Great Australian Bight
VICTORIA
Albury
MELBOURNE
C. Howe
FROM SAN FRANCISCO
Auckland
NEW
Bass Strait

terminal ports. The distances to be run and the weather which may hinder progress, if taken into account in connection with this, certainly warrant our use of the name Ocean Railways to our regular steam lines at any rate.

And like our land railways in their annual reports, the P. and O. and other companies give us the annual mileage steamed by their vessels. In 1887 we thus learn that it was no less than 2,317,654 miles, and that the value of the coals used in their vessels that year was £449,588 !

The blue lines on the accompanying map of the routes of the P. and O. Company show its connections with that of the British India.

CHAPTER VIII.

The development of British commerce with the East concurrent with that of ocean steam communication with it, together with origin and growth of British India, Orient, and other steamship companies.

We come now to the British India Steam Navigation Company, which was incorporated in 1856, and which came into existence out of the gradual development of the Eastern trade. The distances annually traversed by its vessels aggregate no less than 5,000,000 miles, or more than double the yearly mileage of the steamers of the P. and O. Company. The large scale of its operations and the regularity with which its undertakings are fulfilled give it an important influence on every port along the littoral of the East Indies, in the Persian Gulf, in Burmah, the Straits Settlements, East Coast of Africa, and in the Australian Colonies.

Its fleet numbers 106 vessels, manned by 1,300 officers and engineers and 10,000 European and native seamen, firemen, and stewards, with an aggregate tonnage of 270,000 tons, or 76,000 tons more than the total of the fleet of the P. and O. Company.

Its first operations dated from 1855, when the East India Company resolved upon establishing a regular mail service between Calcutta and Burmah. The first of the steamers placed on the line were the steamships *Cape of Good Hope* and *Baltic*, which were despatched to India from London round the Cape.

The founder of the Company and its Chairman, the late Sir William McKinnon, proceeded to India in 1861–2, in order to renew the mail contracts with the East India Company and to inaugurate a complete general system of operations and extensions. In 1864 six weekly lines of service had been established.

In November, 1869, when the Suez Canal was opened for traffic, the Liverpool and Glasgow steamship owners rushed through it to seize upon new ports. The first vessel, however, which had the honour of taking advantage of this short cut between Europe and the far East was the steamship *India* of this Company.

The increased consumption of coal necessitated by the long voyages in the route thus opened, and the cost of its supply, now accentuated the demand which had arisen in 1856 by our commercial marine for more economical engines. These were first supplied in the year named by Messrs. Randolph Elder & Co., of Glasgow, who fitted two paddle-wheel steamers of the Pacific Steam Navigation Company with what have since been known as compound engines. They were so called, as we will notice more fully further on, by using the same steam first under high and then under low pressure. The British India Company at once adopted this new style of engine, and improved its fleet in order to meet the new state of things brought about by the opening of the Canal by adding to it steamers of larger capacity than it had heretofore comprised.

Keeping in view the growth of the trade, and the requirements of the Government service, the steamers subsequently built were of greater capacity, ventilated by the most approved methods, and provided with surface condensers, then a new invention, of which the Company were among the first to take advantage, and all its steamers built after the year 1863 were so fitted. This forethought not only effected the anticipated economy of coal, but proved of signal advantage on the occasion of the Abyssinian campaign. On arrival of the troops at Annesly Bay, water was found to be a pressing want, and the advantage of these surface condensers now became apparent, as none of the other steamers employed in the expedition were fitted with them. Three of the Company's nine steamers there as transports immediately commenced condensing water, and delivered 30,000 gallons per day, for the support of the troops and animals, and were retained for this purpose during most of the campaign, whilst the other six made repeated trips to and from India. Testimony was borne to the immense value of this water supply at such a crisis, and had it not been for this assistance until other sources of water supply were found, the occupation of Annesly Bay would have been, for some time at least, impracticable.

In 1872 the Company entered into a mail contract with the East India Company for a monthly service from Aden to Zanzibar. There was certainly a great need of such a service, for, on the arrival of the first steamer at the latter port with London dates ten days old, it was found that the latest to hand there were of the previous June! It is not unreasonable to regard this service, thus inaugurated, as the first link in the chain of events which have recently led to the establishment of our protectorate over Zanzibar and that of the East African Company, in which the distinguished Chairman of the British India Steam Navigation Company took so leading a part.

Elsewhere in the East the Company in extending its operations has also developed new important trade centres. Between Bombay and Calcutta, for example, its steamers now call regularly at eighteen ports along the coast between these points, taking Çolombo and Point de Galle on the route.

Its line has also been pushed up the Persian Gulf to Busreh, calling at various African and Arabian ports which were centres of the slave trade. Its influence so undermined this inhuman traffic that the native port officials interested in it threw every obstacle in the way of the Company they could, in order to make its undertakings unprofitable. Amongst other of such acts was their subjecting its vessels to quarantine in its most objectionable form and on insufficient grounds. Although these arbitrary proceedings were complained of to our Foreign Office, and doubtless brought under the attention of the proper authorities, they were suffered to continue. As a consequence many of these ports which used to be called at regularly are now only visited by the Company's vessels occasionally.

In 1880 the Queensland Government entered into a contract for a mail service from London through the Torres Straits to Brisbane, calling at seven of the intermediate ports between it and Thursday Island. This not only has largely benefited the trade of Eastern Australia, besides conveying 61,000 new colonists to the country, but also affords passengers to and from Australia an opportunity of availing themselves of the picturesque and smooth water voyage viâ Torres Straits and Java.

The steamers of the British India Company are chiefly employed in what may be regarded as the local Eastern trade, while those of the British India Associated Steamers, Limited, established in 1873, under the same management, are employed in running in the trunk lines from London to India and Queensland. Four out of the latter thirteen are over 5,000 tons gross burden, one of 4,000 tons gross burden, and two are of 4,713 and 4,938 tons gross, respectively. Three of these vessels are fitted with engines of 700 horse-power nominal, and two with 600 horse-power nominal. The other six average over 3,000 tons gross measurement, and 405 horse-power nominal, one of which, however, the *India*, is 4,065 tons and 500 horse-power nominal.

The larger boats are fitted up with all the modern improvements in their internal accommodation for passengers, and the majority of them are under the command of officers of the Naval Reserve. When the Mutiny broke out in India in 1859, the 35th Regiment was brought out by one of the vessels of the line from Ceylon to Calcutta, and was the first reinforcement to our troops at this critical time. In 1863 thirteen steamers of the fleet were taken up by the Government in connection with the Abyssinian Expedition.

In review of the steady expansion of the British India Steam Navigation Company, which we have now traced from its foundation down to its present position, we may justly credit its managers not only with having conducted its affairs with consummate boldness and ability, but also with having manifested a power of organisation of no common kind. As an additional confirmation of this we refer our readers to the extensive ramifications of the Company's operations shown on its maps. It is, moreover, a proof of the beneficial influence of the British rule that commerce should have so rapidly sprung into existence in the comparatively unknown places that were brought to light by the Company's steamers; and that the British flag should have been respected in ports which were previously known only as the haunts of pirates and slavers.

Besides the P. and O. and British India Companies there are other regular steamship lines engaged in the Eastern trade. Amongst them are the Anchor and Clan Lines, one sailing from Liverpool and the other from Glasgow.

Amongst the foreign lines of steamers engaged in this trade, the Messageries Maritimes, founded in 1852, is our most important competitor. Its fleet comprises 58 steamers, handsome in rig and appearance. The latest additions to this fleet is the *Ville de la Ciotat*, 6,500 tons, and 7,000 indicated horse-power, and intended for the Australian trade. A vessel for the China line and one for the Brazilian trade are in progress. This French line is the greatest rival in the Eastern carrying trade with which the P. and O. Company has to contend. So successful has it been in this respect that for several years past it has run a line of freight steamers between Marseilles and London.

The later boats of the Messageries hold their own also in their passenger accommodation against any of the floating palaces of the other lines, and their *cuisine* is so excellent that although their rates are slightly higher than those of the P. and O., they secure a good many English passengers. Although they are a foreign company, we may fairly therefore include them amongst our Ocean Railways to the East.

The Austrian Lloyd and Rubattino Companies have also services to China and the East Indies.

Our history of the extension of ocean steam navigation to the far East, and especially to our Australasian Colonies, would necessarily be incomplete without a special reference to the ORIENT LINE, as it is popularly called. It was founded in 1877 by Messrs. Anderson, Anderson, & Co., in conjunction with Messrs. F. Green & Co., two well-known London shipping firms, under the conviction that the time had arrived for the establishment of a direct line of first-class steamers to Australia. How admirably they have succeeded in this intention is proved by the past success and present position of the Company formed to carry it out.

The line commenced running in 1877, at intervals of six weeks, with four steamers chartered for the purpose. One of these vessels, the *Lusitania*, 3,825 tons register and 3,000 indicated horse-power, was advertised to make the passage between London and Melbourne in forty days, and did so. As this was the quickest passage by ten days previously made to Australia, it excited considerable attention both in this country and in that Colony. And well it might among the latter, for they would naturally contrast it with their communication with the mother country by sailing vessels; for a voyage by a clipper ship took ninety days, and by an ordinary vessel one of six months was by no means an uncommon event.

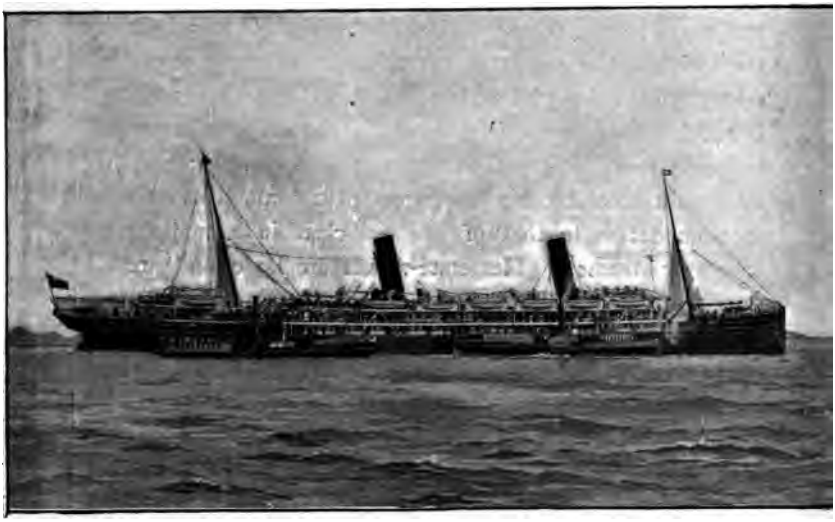
The increase of traffic soon demanded that a fortnightly service should be established, which was begun in 1880 with the four chartered steamers mentioned, namely, the *Garonne*, *Lusitania*, *Chimborazo*, and *Cuzco*—which were then purchased by the Orient Company from their owners, the Pacific Steam Navigation Company—and the *Orient*, specially built by the former for the Australian trade. Her dimensions were as follows: Length, 400 feet; breadth of beam, 40 feet 6 inches; measurement, 5,365 tons register; and she was fitted with engines working up to 6,000 indicated horse-power. She was built by Messrs. Robert Napier & Co., Glasgow, and launched in June, 1879. She was the largest steamer at this date which had been constructed on the Clyde, and the first vessel, we believe, in accordance with the requirements of the Admiralty for ships which might be employed as cruisers in case of war. On her trial trip the *Orient* steamed 17·1 knots, or 19½ statute miles, per hour, and on her first voyage out she made the run from Plymouth to Adelaide round the

Cape of Good Hope in 37 days, or at the rate of 14 knots or 16 statute miles per hour. Her run from Plymouth to the Cape was made in 17 days 20 hours. The fleet was subsequently reinforced by the *Austral*, about the same dimensions as the *Orient*, but fitted with engines of 7,000 indicated horse-power. Five other well-known vessels of increased size and speed were subsequently added to it.

The internal passenger arrangements of these new ships are equal to any other vessels afloat. The *Ormuz*, built by the Fairfield Company, for example, has a magnificent deck saloon, 56 feet long by 33 feet broad. Her promenade deck is 240 feet long by 50 feet in width, so that her passengers in going round it ten times get a walk of a mile; and her saloon for second cabin passengers, placed aft, is superior in accommodation to that of the first-class in a majority of passenger steamers. Her state-rooms are large and prettily fitted up, a few being made for only one berth, others for two berths, and others again large enough for a family.

In short, she is a floating hotel fitted up with all modern improvements, and is in every respect worthy of the line and the Colony between which and the mother country she is a link. Her length is 481 feet and her breadth 52 feet. She measures 6,116 gross registered tons, and is fitted with engines working up to 8,500 indicated horse-power, which are on the triple expansion principle, and are worked by seven large boilers. Her best run in 24 hours was 420 knots, or within a fraction of 500 statute miles. A passage from Plymouth to Adelaide in 31 to 32 days is an ordinary occurrence, but the *Ormuz*, on her first voyage home in 1887, delivered her Australian mails in London in 27 days. In her second voyage to Australia in October of that year, she made the passage between Plymouth and King George's Sound in 26 days 2 hours.

These rates of speed may appear small when compared with the record of recent Atlantic voyages, but the question of coal consumption must be taken into consideration in connection with the Australian route. The coaling stations along it are about twice as far apart as are Liverpool and New York. A crack Atlantic liner which can steam twenty knots or so between these ports would, as mentioned in the case of the *Teutonic* steaming round the Cape to Bombay, have to reduce her speed considerably in order to economise her fuel. Did she not do so her results commercially would not be satisfactory to her owners.



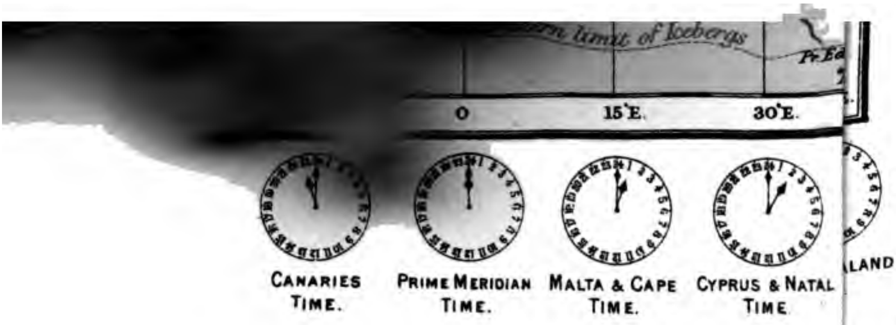
S.S. *Ophir*, of the Orient Line.

The *Ophir*, built by Messrs. Robert Napier & Sons, and launched in April, 1891, is the last addition to the Orient fleet, and is the largest and most powerful ship built for the Australian trade. Her length over all is 482 feet, and between perpendiculars 465 feet. Her breadth of beam is 53 feet 6 inches, and moulded to the upper deck it is 37 feet. Her displacement at the load-line (24 feet 6 inches) is 10,500 tons. Her gross registered tonnage is 6,500, and her effective horse-power 9,500. She is fitted with two triple expansion engines working twin screw propellers, and having cylinders respectively of 34, 51½, and 85 inches in diameter, with a stroke of 54 inches. Her seven cylindrical boilers are of steel with a working pressure of 160 pounds to the square inch. There is a fore and aft central watertight compartment dividing the engines, and the boiler-rooms are placed in watertight compartments, with other similar compartments between them. Thus if ever one of the engines or boiler-rooms were flooded by a collision or any other accident, the other would not be involved in it. It is unnecessary further to describe the construction of the vessel, so far as safety and comfort is concerned, than to say that all the recent improvements, to which we call attention further on when describing the great Atlantic liners, have been adopted in the construction of the *Ophir.*

With regard to her first-class passenger accommodation, the following necessarily concise reference to it will be rather a surprise to those accustomed only to the palatial fitting-up of our crack Atlantic liners.

The promenade deck, reserved for first saloon passengers, is 252 feet long by 51 feet wide. At the forward end of this deck is the drawing-room, a large, richly-decorated apartment covering an area of 1,200 square feet, the wall lined with inlaid marqueterie panels, and adorned with landscapes by Mr. Napier Hemy, and figure subjects by Mr. Walter Crane. The furnishing is in blue velvet. The room is entered from the promenade deck, also from the grand stairway which leads down to the saloon entrance on the upper deck, and thence to the main deck. Writing-rooms, appropriately furnished, attached to it. About the middle of the promenade de rises the dome which gives light to the saloon, leaving at tl sides ample space for dancing. At the fore end of the dom doors open into a balcony overlooking the dining saloon, an containing an organ and seats for a choir or band. Furth aft is the first-class smoking-room, a spacious apartment, wit an area of about 800 square feet, lighted by large squa windows and octagonal skylights. The sides are panelled i oak, and the furniture includes comfortable lounging-chai and settees, covered with leather. This room has cos corners, where a quiet rubber may be played, and place about are small oak tables. It is entered from the promenad deck by a porch, with a stair on each side, connecting wit the saloon and the cabins on the main deck, so that it can b reached without going outside in bad weather. A bar an lavatory are attached. Abreast of the smoking-room on th promenade deck, good deck space is available for dancing, an for games, such as cricket, quoits, etc.

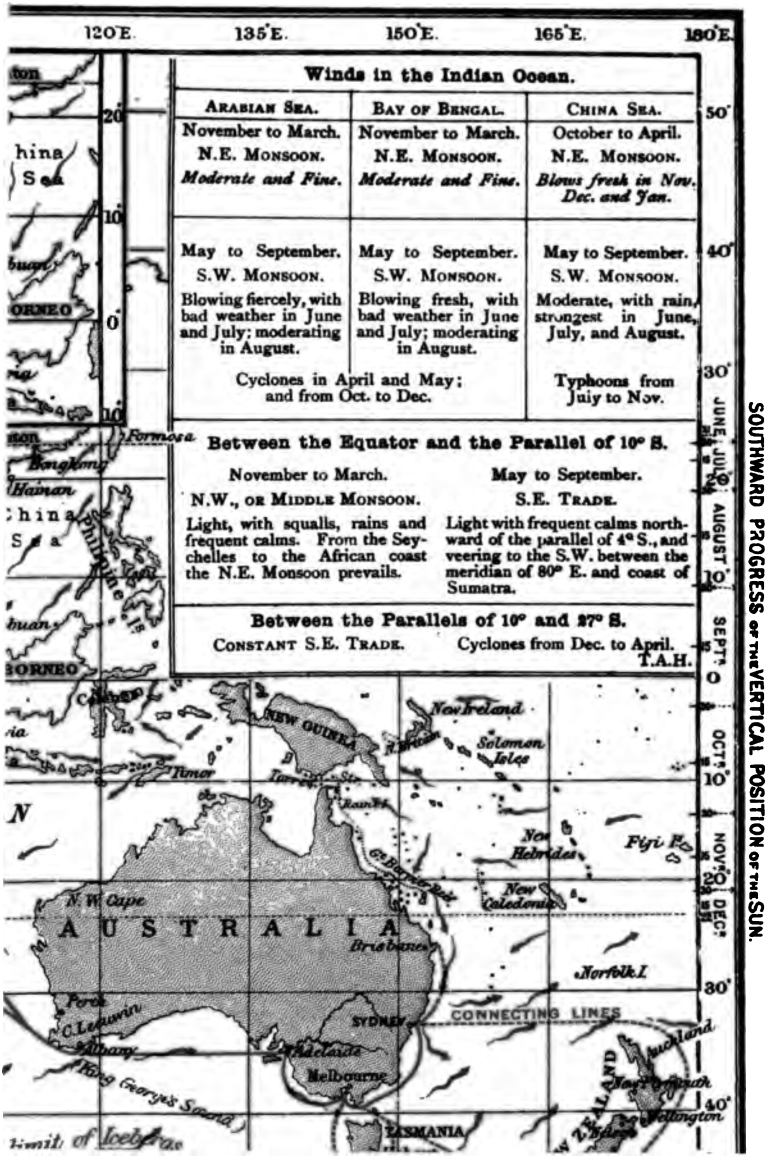
The first-class dining saloon is on the upper deck, right i the middle of the ship. It is richly panelled in satinwoo and rosewood, is well lighted from the sides by large squar windows, and from above by an arch-shaped dome 20 feet i height, 27 feet long by 20 feet 6 inches wide, filled wit painted glass. Outside is a steel roof pierced for ligh Between the outer and inner roofs electric lamps are place which shed a soft light on the saloon below. Round the side and end of the dome, high up, are eleven large round port filled with stained glass of beautiful design with handsom carved gilt frames representing flowers, fruit, etc., while i niches between stand female figures sculptured in woo holding suspended from their hands electric light lamps, whic



10 000 JULY 1883.

EN ENGLAND & AUSTRALIA.

ENT CHART.



Winds in the Indian Ocean.

ARABIAN SEA.	BAY OF BENGAL.	CHINA SEA.
November to March. N.E. MONSOON. *Moderate and Fine.*	November to March. N.E. MONSOON. *Moderate and Fine.*	October to April. N.E. MONSOON. *Blows fresh in Nov. Dec. and Jan.*
May to September. S.W. MONSOON. Blowing fiercely, with bad weather in June and July; moderating in August.	May to September. S.W. MONSOON. Blowing fresh, with bad weather in June and July; moderating in August.	May to September. S.W. MONSOON. Moderate, with rain, strongest in June, July, and August.
Cyclones in April and May; and from Oct. to Dec.		Typhoons from July to Nov.

Between the Equator and the Parallel of 10° S.

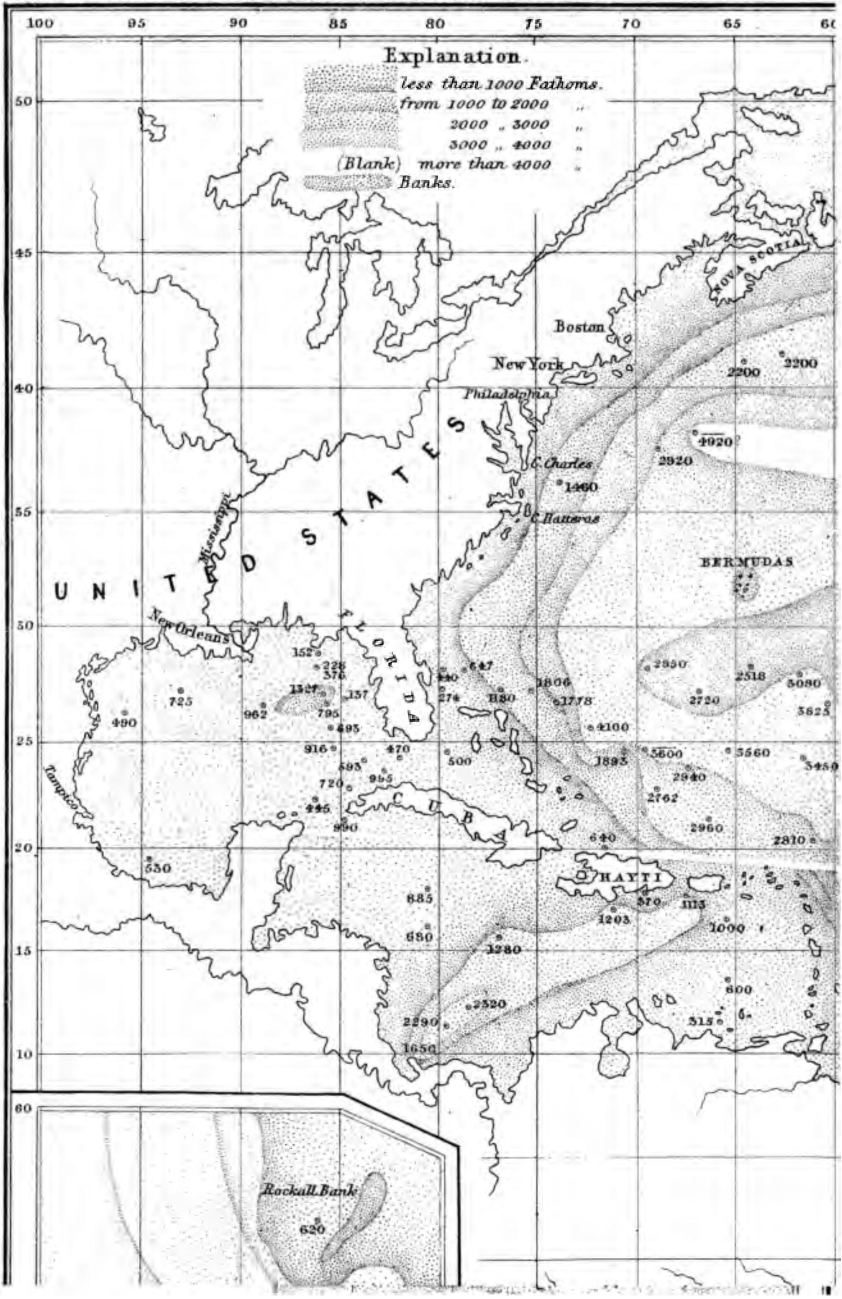
November to March.	May to September.
N.W., OR MIDDLE MONSOON.	S.E. TRADE.
Light, with squalls, rains and frequent calms. From the Seychelles to the African coast the N.E. Monsoon prevails.	Light with frequent calms northward of the parallel of 4° S., and veering to the S.W. between the meridian of 80° E. and coast of Sumatra.

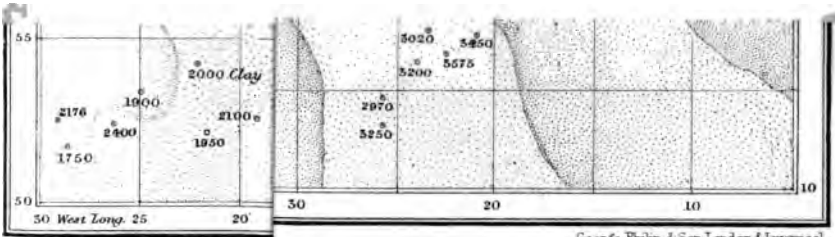
Between the Parallels of 10° and 27° S.

CONSTANT S.E. TRADE. Cyclones from Dec. to April.

T.A.H.

BASIN OF THE NORTH ATLANTIC OCEAN.





George Philip & Son, London & Liverpool.

hang over the middle line of the dining-tables below. Under the arched spaces at each end are the shields of Great Britain and of the four leading Australian Colonies, with figures representing the industries of the countries.

Following the example of some of our land lines this Antipodean railway has provided its passengers, at a nominal cost, with a voluminous, well written guide to the many points of interest along its route, and also with a description of Australia and New Zealand. The fauna of the ocean and the weather which may be expected on a voyage are also described, as well as all that is mysterious to the landsman in navigation.

We can hardly close this notice of our great Eastern ocean railways without calling the attention of our readers to the magnitude of the trade which they have largely contributed to develop, and in which they are now employed.

The total exports and imports from and to India, Ceylon, the Straits, Labuan, and Hong Kong, amounted in 1889 to £206,235,418, and the shipping employed in it aggregated 28,523,702 tons entered and cleared. The total exports and imports to and from Australia amounted in the same year to £105,142,929, and the tonnage entered and cleared to 15,012,853 tons. The net tonnage which passes through the Suez Canal is also in point here. In 1870, the first year after it was opened, it amounted to 436,609 tons, in 1880 to 3,057,421, and in 1887 to 5,903,025 tons. In the latter year 75⅝°/o of the gross, or 76¼ of the net tonnage passing through the Canal was British, as were 2,330 vessels out of the 3,137 that did so.

CHAPTER IX.

Official recognition of the services of the Cunard Company, and a voyage in one of their steamers in 1848.

We have now come back again in our history to the period in ocean steam navigation when it may be regarded as having passed the experimental stage. In further confirmation of this we have a report in 1853 of a Select Committee of the House of Commons relative to vessels under contract for the packet (or mail) service, which thus referred to the Cunard Line:

"We find that the vessels employed by it are much more powerful and, of course, more costly than is required by the terms of the contract, and that, as regards their fitness for war purposes, they are reported by the Committee of Naval and Military Officers as being capable of being made more efficient substitutes for men-of-war than any under contract for the packet service. The service has been performed (by them) with great regularity, speed, and certainty—the average length of passage from Liverpool to New York being 12 days 1 hour and 14 minutes."

By a clause in the original contract with the Government for carrying the mails, the Cunard Company was bound to construct their vessels of sufficient strength and capacity to enable it to employ the steamers as gunboats if required. If such a contingency had occurred, from the general excellence of their construction and their admirable equipment, they would certainly have rendered a good account of themselves. In another capacity, however, at times of great national emergency, their services have proved invaluable to the State. For example, at the outset of the Crimean War, and during its continuance, eleven of the Company's steamers, with an aggregate of 23,080 tons measurement and a total of 4,740 horse-power, were employed as transports. They carried troops, horses, and military stores to the Crimea, and were of inestimable value in conveying the wounded, invalided, and the convalescent back from it to Scutari, and effectively aided in keeping up by steam the line of communication between the seat of war and the base of operations. The Duke of Wellington, who refused countenancing the introduction of ocean steam navigation because of his unwillingness to interfere with the existing state of things, lived just long enough to see how useful in grim war this new propelling power could be made.

At the time of the Crimean War the Cunard Company was the only steamship line in existence that could supply, to any extent, such an auxiliary service. The growth of our ocean steam marine since then has enabled the State on several subsequent occasions to draw heavily upon it for a similar service. This was notably the case in our occupation of Cyprus in 1878, in the Egyptian Campaign of 1882, and in our operations in the Eastern and Western Soudan in 1884–85.

The contract with the Government already referred to fixed the payment, as then stated, to the Cunard Company for the carrying of the mails on a sliding scale according to the amount of postal matter carried by the steamers. The actual revenue it received during the first seven years of the first contract was admitted to be a large sum for the service rendered, but as explained to another Parliamentary Committee by Sir John Burns, who had then succeeded his father as Chairman of the Cunard Company, that in the original contract, besides the restrictions about the using of the vessels in time of war, they were obliged to carry naval officers on board, and to do other expensive and troublesome things. As these restrictions were now taken away, their contract had been reduced to £70,000 a year, and their obligation to carry naval officers had been cancelled.

The policy so heartily recognised by the Special Committee in its report to the House of Commons referred to in a previous page, about the superior character of the vessels supplied under the first mail contract by the Cunard Company, was continued. Messrs. Cunard, Burns, and MacIver, when that contract was obtained, resolved to build the finest ships which the best naval architects could design, and to equip them in an absolutely faultless style, sparing neither money nor patient industry to fit them for the Atlantic service, in such a manner as to carry out Mr. Cunard's idea of "railway trains on the ocean." One of the principles upon which they acted was that each ship added to the fleet should be superior to those which preceded her, which was illustrated in our comparison of the size, power, and capacity of their first ship, the *Britannia*, with the *Persia*.

With a Scotch canniness which, as will be seen further on, left the Company behind other companies in the accommodation they provided for the travelling public, and the trade generally, we are informed by the biographer of the late Sir George Burns that it was also "the policy of the Company that others should experimentalise, and when the novel principle had been proved by indubitable tests, then, and not till then, to introduce it into their next vessel." As a consequence of this excessive cautiousness, it was not until 1852 that the Cunard Company ventured on building a ship of iron and fitting her with a screw.

It is, however, due to the Company to say that it has well earned the honour and credit of having carried hundreds of thousands of passengers across the Atlantic, and millions of letters in their ships, without an accident to the former or the loss of the latter. Some looked upon this as "a wonderful run of luck," and others as "a special interposition of Providence." But as Mr. Hodder justly remarks in his biography of the late Sir George Burns:

"Luck is far too fickle a thing to attend upon any scheme for forty or fifty years in succession, and Providence does not favour one particular firm to the disadvantage of others," and that while Sir George trusted in Providence, and believed implicitly in the power of prayer, "he was also a firm believer in doing work well, and in subordinating profit and speed to safety, comfort, and efficiency." It was, therefore, to the admirable measures adopted by the Company to prevent accidents, and to the vigour with which they were enforced, that this remarkable immunity from casualties must be attributed. Although criticising the rigid carefulness it followed with respect to iron ships and the screw, it would have been well for the interests of some of the other steamship companies, who came early into the field, to have erred thus on virtue's side. Had they done so the many valuable lives lost in their wrecked ships would have been saved. Navigation of the ocean by steam was then a comparatively new science. Captains hitherto engaged in navigating sailing ships had, in fact, to learn it. Recognising the necessity, the Cunard Company compiled an exhaustive code of instructions for the use of their captains, officers, engineers, and every man on board their vessels, stating plainly their individual duties and laying down rules for their guidance under all circumstances. Aware of how much depended upon the acuteness of vision possessed by officers and look-out men, the greatest care was taken to guard against weak sight or colour-blindness in every one connected with the sailing department of their ships. Precautions were no doubt taken by other companies at this early period of ocean steam navigation, but from their losses we may assume that they were not so carefully compiled or so rigidly enforced as by the Cunard Company, and it therefore had its well-merited reward.

It may be interesting here to recall a voyage made from Boston to Liverpool by the author in 1848 in the *Niagara*, one of the four new vessels added that year to the Cunard fleet. She was only about 1,800 tons burden, built of wood, and fitted as all ocean steamers were then—with paddle-wheels. Her engines were but 680 horse-power, and her speed 10½ knots an hour. The first-class passenger saloon was a house on deck, with gangways between it and the bulwarks. It was comfortably furnished and prettily painted, and had marine and other scenes between the rows of windows on each side. Two tables ran from end to end. It was entered from the main deck, and the sleeping cabins below were reached by a narrow companion from it aft. There was also a grate fire at the upper end. The roof was used as a quarter-deck, at the stern of which was the wheel-house.

The second cabin passengers had comfortable quarters forward, but were not allowed on the quarter-deck. No steerage passengers were at this time carried by any of the steamers then traversing the Atlantic.

Compared with the living on board sailing ships carrying cabin passengers, that on board the Cunarders was considered luxurious. It included hot rolls instead of biscuits, and fresh milk supplied from the cow carried on board.

The *Niagara* was brig rigged, if we remember rightly, and her square yards in the foremast so slung as to allow them to be lowered on deck. This was done in case of a head-wind, when also topmasts were struck man-of-war fashion. She carried also a naval officer, who was in charge of the mails, and on Sunday the crew attended the service held in the saloon rigged up in man-of-war style.

Boston was three hundred odd miles from Montreal, from whence I started, and this was how I travelled to catch the *Niagara*. The first nine miles of the journey was by steamer up the St. Lawrence to Laprarie, and thence by the Champlain and St. Lawrence Railway—fourteen miles—to St. John's, C.E., situated on the outlet river of Lake Champlain. As Canada was second in America to adopt river steamboats, so she was likewise with railways, for this short one was the second built on that side of the Atlantic.

From St. John's the next stage was to Burlington, Vermont, seventy-five miles up Lake Champlain by steamer, where we arrived at seven o'clock p.m., and remained at an hotel until four a.m. next day. Leaving at that early hour, and after a weary drive by coach on a broiling hot day, Bellows Falls was reached at midnight. After a short drive next morning we struck the terminus of the Boston Railway at Keene, New Hampshire, and soon comfortably reached our destination.

The *Niagara* sailed at one p.m., July 26th, 1848. The weather was exceedingly hot, and very clear in the Bay, but outside of it a dense summer fog hung over the sea. We went into it and through it all the way across the Bay of Fundy, and evidently at full speed. There were no steam sirens as in these days to warn vessels of an approach. The substitute on the *Niagara* was a tin horn blown by a sailor on the forecastle.

Sailors were sailors in those days, and conversed in the lingo in which they are made to talk by Marryat and other authors, as did those on board the *Niagara*.

"You're quite a musician, Jack," said I to the performer on the tin horn during this dismal day.

"Musicianer, yer honour! Confound the old thing! I might as well have a handspike in my mouth, for I'm blowed if I can get the wind jammed into it!"

At eight p.m. in the evening Captain Ryrie, judging he had run his distance, stopped the engines, and fired a gun. In two minutes it was answered from the lighthouse at the mouth of Halifax harbour. Although we had made a capital landfall, we had to lay off the harbour all night, occasionally firing a gun at long intervals, and getting a reply from the lighthouse.

At daylight next morning we sailed into the harbour, and after shipping our coal supply and taking the mails on board, started for our destination. About an hour after leaving the harbour a frigate came in sight out of the fog which still hung over the sea. She fired a gun, and hoisted signals asking us to stop for despatches. She was a pretty sight as she lay to, showing her copper as she rolled. Her name is forgotten, but her destination was Bermuda, with Mitchell, one of the leaders of the Young Ireland party, and who had been tried for high treason and sentenced to a term of imprisonment in that island.

Soon a boat put off from the frigate, pulled as man-of-war's men only can pull, and steered by an officer in uniform. Our naval officer came on deck in his full war-paint, and stood at the starboard gangway ready to receive his brother officer from the frigate. When the latter came on deck he bowed and saluted, and then handed our officer a package of letters, including several in long official envelopes. Ours then bowed, and so did the other, and then went down the side of the ship to his boat and back to the frigate. He was scarcely clear of the *Niagara* before her paddles began to revolve, and we were off again for Liverpool.

Early next morning (Saturday) Cape Race was sighted, as was then the rule for the Cunard steamers both outwards and inwards bound, although of late years a berth of 150 miles is given it by our regular American liners. Many shipwrecks occurred on it during this period, and amongst them was the *Columbia,* one of the first fleet of Cunarders. All the passengers and their baggage and the mails were, however, safely landed. The *Europa*, the last steamer of the fleet to which ours belonged, was nearly lost in trying to make this cape as usual, under the following circumstances:

She had had foggy weather for several days, and consequently no sight of the sun. By dead reckoning on the previous day the captain expected to sight the cape next morning. So at daybreak, while the two men on the look-out on the forecastle, the two others, one on each of the paddle-boxes, and the officers on the bridge were anxiously engaged in peering through the mist for a sight of the headland, the cry came from the forecastle: Breakers ahead on the starboard bow! Breakers ahead on the port bow! And soon from the bridge a circle of broken water was seen ahead of the steamer. It was now perceived that she had run into one of the rock-bound bays along this part of the Newfoundland coast, but with enough room to enable her to be safely turned round and paddled out again.

Some mistake had been made, and in order to ascertain it the dead reckonings were examined, but were found to be correct. Then the spare compasses, with which each ship was provided, were brought up on the quarter-deck to be tested. They all differed from each other and from the one in the binnacle! Here then was the cause of this almost disaster; but it puzzled the officers to ascertain the reason of this aberration of the needle. The steward suggested that as the smoke-pipe from the saloon fireplace had been repaired at Liverpool, it might in some way be the source of the mischief. Upon examination it proved to be so, for its original brass pipe had been replaced by an iron one, which, as my informant concluded, "was soon shifted overboard!"

Early in the sixties the *Africa*, of the Cunard Line, struck a ledge of rocks off Cape Race, and was beached in a sinking condition, if my memory does not deceive me, at St. John's, Newfoundland.

The fog hung heavy over the Banks, keeping the look-out in the forecastle busy jamming his wind into the fog-horn, warning the fishermen of our approach. From all accounts the warning often came too late, for the steamers were on them before they could avail themselves of it. There was often only a scream heard, then a slight crash, the rattling of timbers along the side of the destroying vessel, and all was over with the fishermen, but the steamer kept on her course. The *Europa*, somewhere near the Banks, actually cut right through the centre of a barque in a fog, but happily without injury to herself save the loss of her bowsprit and figure-head.

The sea was as smooth as glass all the way across, as it always is during the days of the year in which we were steaming over it. When the first cable was laid, Captain Maury was consulted as to the most favourable season in the Atlantic for doing so. After examining the results of no less than 240,000 days' observations and a laborious investigation, he informed the Company that the most propitious time for their undertaking was the last of July and the first of August, "and that the steamer with the western end of the cable would be less liable than the other to a gale." This proved true, for the *Agamemnon*, with the eastern end of the cable, came nearly losing the end of the cable, owing to the violence of the wind and waves, while the *Niagara* was sailing with the western end in smooth water and a tranquil sea. It also turned out that between the 20th of July and 10th of August was the time which proved the best.

This paddling over a smooth sea in a steamship, to one who had some months before crossed it in a sailing ship in a continuous gale of wind from Sandy Hook to Cape Clear, was a most enjoyable novelty.

On Saturday at four a.m. the Bloody Foreland, on the north-west coast of Ireland, was sighted. The voyage, therefore, from land to land was but seven days—not bad for a steamer of the size and power of the *Niagara.*

As the Cunarders then usually came north about when homeward bound, we had during the day a panoramic view of the coast of Ireland, including the Giants' Causeway, and in a beautifully clear August day. Excepting that caused by the usually long swell of the Atlantic, which prevails even in the calmest weather, the ship had no motion until off the Calf of Man, when some of us felt from her short rolls and pitches as if she was going through a kind of corkscrew channel. At four a.m. on Sunday we were moored to the Company's buoy off the Cobourg dock, then big enough for even Cunarders, but which now could only receive over its sills one of their larger steam tenders. The run from Boston was thus made in

10 days 9 hours, but deducting seven hours' detention off Halifax harbour, and allowing five hours for our call there, in 9 days 21 hours. The *Europa*, however, often made the run from port to port in less time, arriving at Liverpool on Saturday afternoon—an achievement then in ocean steaming which excited as much surprise and interest as some of the late quick trips of the American liners.

CHAPTER X.

Marking the improvements from the establishment of the Inman and Allan Steamship Lines to that of the White Star, etc.

FROM this digression we return now to our main subject, and call attention to the commencement of that period in the history of ocean steam navigation when iron took the place of wood as a material for shipbuilding, and the screw propeller that of the paddle-wheel. The *Great Britain*, as already stated, was the first vessel of that type built for the North Atlantic trade, but afterwards was transferred to the Australian. The *Sarah Sands*, a full-rigged iron ship, fitted with what was only an auxiliary screw propeller, followed, and for several years ran between Liverpool and New York. Some years later her engines were taken out of her, and she was burnt at sea.

The first regular line of iron screw steamers between Europe and America was the International, or, as it is better known by the name of its founder, the Inman Line, established in 1850. The first steamer of their fleet was the *City of Glasgow*, of 1,600 tons, 227 feet in length, and with 32 feet beam. She was followed by larger vessels, all full ship rigged, and fitted with engines of such increased power as soon took them out of the category of mere auxiliary screw steamships. Their speed also was increased through improvements in the pitch of the screw, and by being fitted with more powerful engines. They were all named after cities, and twenty odd years ago some of the steamers of this line held the blue ribbon of the Atlantic, as the two last of them did until recently. Amongst the most celebrated vessels at that period were the first *City of Paris* and the *City of Brussels*. In August, 1869, for example, the former made the run between Queenstown and Halifax in 6 days 19 hours 25 minutes, and the latter, in December of the same year, made the run between New York and Queenstown in 7 days 23 hours 33 minutes. As we have to return again to this historic line, we will only add here that it was the first to undertake the conveyance of emigrant steerage passengers by steam across the Atlantic. The result was that a great impulse was given to emigration from the United Kingdom to the United States, from the results of which both countries have largely benefited, and no branch of business between them more so than steamship owners, for reasons easily understood.

In 1852 the Canadians, with that commercial enterprise which characterises them, and who built the pioneer steamer *Royal William* in 1833, resolved to have a steamship line of their own. Their British mails had hitherto been carried by the Cunarders, and at first were landed at Halifax and conveyed overland in summer to Pictou, on the Gulf of St. Lawrence, and thence by steamer to Quebec. In winter they were landed at Boston, and conveyed overland through Maine to Montreal and Quebec. This was slow work, for in 1842 the author remembers the following announcement in the *Montreal Herald* newspaper:

"FORTY-TWO DAYS LATER NEWS FROM EUROPE.

"The Cunard steamer *Britannia* has arrived at Boston with forty-two days later news from Europe, but the only file of newspapers which has come to hand was received by His Excellency the Governor-General."

In the year named the Canadian Government entered into a contract with the Messrs. Allan for the establishment of a line of ocean steamships suited to the requirements of the passenger traffic between the United Kingdom and Canada, and for the conveyance of the mails.

The Allans were a Glasgow family, of whom both father and sons owned and had sailed for many years a fleet of sailing ships of about 600 tons burthen between Quebec and Montreal and Liverpool and Glasgow. They were therefore well qualified to undertake and carry out successfully such an important undertaking.

The service at first was a fortnightly one between Liverpool and Quebec, calling at Moville for the mails. The Crimean War, which occurred soon after the line started, not only temporarily stopped its running—for all its steamers were taken up by the British and French Governments for transport purposes—but it also seriously affected the trade of Canada with other countries. On the termination of the conflict in 1859 trade revived, and the service was made a weekly one.

In summer the steamers took the St. Lawrence route, either round Cape Race or by the Straits of Belleisle, the latter being twenty hours shorter than the former. It had also the advantage of being the shortest open sea route between Europe and America, for the distance between Moville and the Straits is 1,119 miles, and land is only lost sight of for five and a half days of even the slow comparative steaming of the vessels of this line.

The St. Lawrence route in summer proved itself, before the era of fast steaming to New York began, to be superior to that by that latter for the transport of mails and passengers. This became conspicuous when the Grand Trunk Railway was connected with the Inter-Colonial at Rimouski—160 miles below Quebec. The Allan steamers, even as early as that date, were thus enabled to land the mails on Saturday, and sometimes on Friday, after leaving Moville with them on the previous Friday. But unfortunately the route was closed in winter, and the line had then to abandon it for Portland, Maine, during that season. It was, however, only 288 miles distant by rail from Montreal and Quebec, and accessible in all weathers.

The first vessels of the Allan Line were only 1,500 tons gross measurement, but, as in the case of those sailing to New York, as the trade of Canada increased and its population grew, steamers of larger size and greater speed were added to its fleet. Amongst these earlier additions was the *Sardinian*, built by Messrs. Robert Steele & Co., of Greenock, 400 feet long, 42 feet 3 inches beam, and measuring 4,376 tons gross and 2,577 register. Her engines were of the compound type and worked to 2,800 indicated horse-power. She had accommodation for 180 cabin, 60 intermediate, and 1,000 steerage passengers. The saloon on the awning deck is 80 feet long by 41 broad, and richly decorated and furnished in equally as rich style as any of the New York liners of her day. On three occasions in 1877 the *Sardinian*, though only steaming fourteen knots an hour, landed her mails at Rimouski on Friday. The mails and passengers were as a rule always landed at Moville on the Sunday week after they were taken on board at Rimouski.

The *Sarmatian*, another vessel of the line, was chartered by the Government during the Ashanti War to convey troops to Cape Coast Castle, and made an unusually quick run thence to Gibraltar with an important telegram, announcing the capture of Coomassie, from Sir Garnet, now Viscount Wolseley.

The largest vessel built by the Allan Company has been the *Parisian,* 440 feet long, 46 feet beam, and measuring 5,600 tons gross. She was built in 1880 by Messrs. Napier, of Glasgow, of mild steel, and fitted through her entire length with a double bottom, divided into watertight compartments, and fitted with compound engines of great power. As will be seen further on, the first marine vessel built of steel was another ship of this line, named the *Buenos Ayrean.* But it not only deserves credit for taking the lead in adopting this new material, but also in adopting flush in-covered decks—a system now universally adopted. For many years the owners saw the necessity for this covered-in arrangement, and adopted it notwithstanding the technical rules of the Board of Trade respecting tonnage measurement for harbour and other dues. This, as compared with the owners of open-deck ships, placed them under a disadvantage so far as expense was concerned. When, however, the attention of the Board of Trade was called to the importance of the innovation by the circumstances connected with the loss of the *London* in the Bay of Biscay, the Department conceded the point of "covered-in" ships.

We come next in chronological order of succession to the Hamburg Line, which commenced running June, 1856. The celebrated North German Lloyd Steamship Company, founded by H. H. Mereo of Hamburg in 1856, had all its first vessels built on the Clyde by the Messrs. Caird, and commenced its service in 1858. Lately they have had several large vessels built by the Vulcan Company at Stettin. These two lines call at Southampton, and are replete with passenger comforts both as regards living and the fitting-up of the saloons and cabin state-rooms. Some of the later ships are fitted not only with twin screws, but also with triple expansion engines.

In 1862 the North German Lloyd was followed by the equally renowned Compagnie Générale Transatlantique. Some of its vessels were built by Napier & Sons on the Clyde, and others by Messrs. Palmer on the Tyne. The Italian Rubattino Line obtained its first fleet of steamers from the latter firm, as did also the excellent Red Star Line, sailing from Antwerp to New York and Baltimore, and which was established in 1873.

The Guion Line was evolved by its owners, the Messrs. Guion & Williams, out of their old and well-known Black Ball Line of Packets, sailing between Liverpool and New York. These vessels were largely engaged in the emigrant passenger trade, and some of them were quick ships. For example, the *Adelaide*, which came down the Narrows at New York with the Cunard steamer *Sidonia*, when both were bound for Liverpool, reached the Mersey before her. The Company, when it entered into business as a steamship line, was known as the Guion Line. Their early boats were nearly all built on the Tyne by the Messrs. Palmer, and the first of their fleet, the *Manhattan*, sailed for New York in 1866. The firm still devoted much attention to emigrant traffic, and carried, by a contract with the Mormon authorities, large numbers of their proselytes from Europe. Their steamers were gradually increased in size and speed, and, as we shall see further on, the line once held the blue ribbon of the Atlantic.

We come now in the course of our narrative to another important epoch in the history of ocean steam navigation, marked by the introduction of a type of vessels which were not only new, but in many respects greatly in advance of those which had previously been constructed for the service.

The first of these vessels were built for the Oceanic Steam Navigation Company, founded in 1869 by Mr. Thomas H. Ismay, and popularly known as the "White Star Line," from the flag under which they sail.

This flag had formerly floated from the mast-heads of a fleet of sailing clippers established half a century ago, when the great rush took place from England to the Australian gold-fields. The impetus then given to the over-sea trade of the United Kingdom by this and other influences, led to the replacement of the old style of small sailing ships by the large clippers, which, before the era of steam, carried Her Majesty's mails, as well as her subjects and their merchandise and enterprise, to the ends of the earth. During the seven years of the gold excitement in Australia, the White Star ships carried about half a million adventurers to that country, and for many years afterwards were almost the exclusive carriers of the steadily increasing commerce between it and the United Kingdom.

In 1867, Mr. Ismay took over the White Star fleet, and became its managing owner, and two years later founded, as stated, the Oceanic Steam Navigation Company, in which he was a year later joined by Mr. William Imrie in this new enterprise. The projectors of this enterprise found no difficulty in securing the capital needed to carry it out, for the fully paid-up £1,000 shares of the Company were at once privately taken up by the managers and their friends.

Hitherto, our great shipbuilding yards had chiefly been on the Clyde, and had come to be justly celebrated the world over for the work they had turned out, both in the hulls of the vessels they constructed, and in the engines with which these steamers were fitted. But these Scotch shipbuilders, up to the epoch to which we now introduce our readers, had been largely influenced in their models and styles of construction by what we may term the traditionary notions of shipbuilding. Like the founders of the Cunard Company, they rejected new ideas with reference to it until they had been proved by the experiments of others, or forced upon them by the pressure of popular demand for certain improvements, which comprised amongst others those affecting the comforts of passengers.

The only rivals with which these Clyde shipbuilders had hitherto to contend were the shipbuilding yards on the Mersey, the Tyne, and the Thames. But another, and in fact a revolutionist in shipbuilding unexpectedly sprang up before them on the Lough of Belfast, a city heretofore chiefly celebrated for its linen and other manufacturing industries.

This event in the history of Belfast was brought about by the order of the Oceanic Steam Navigation Company to Messrs. Harland & Wolff for the construction of their fleet, and published to the world by the appearance in the Mersey in February, 1871, of that specimen of their handicraft, the ss. *Oceanic.* Her yacht-like lines and general symmetry, together with her improved passenger accommodation, attracted not only universal admiration here, but also on the other side of the Atlantic, for on her first arrival at New York, no less than fifty thousand persons visited her. In fact, the improvements made in the *Oceanic* as regards passenger accommodation were so striking, that the older companies have since generally adopted them in their own steamers.

Formerly, for example, the saloon cabins had been always placed aft under the quarter-deck. This was, according to naval etiquette, the place of honour in a ship, but not a comfortable one in rough weather, for it was at one end of the see-saw to which she treated her passengers when pitching. At all times it subjected them to the unpleasant sensation caused by the screw propeller, and most uncomfortably so when that useful appendage "raced."

Little or no adequate attention had been paid to the ventilation of the saloons or state-rooms in the older ships. Both their builders and owners seemed, by their neglect of this important matter, to labour under the notion that the "stuffy air" and "bilge-water smells" which haunted these parts of the ship, were in the very nature of things amongst the disagreeables which landsmen had to pay as part of the tribute demanded by Neptune from all who ventured to sojourn in his dominions.

In the older ships the cabin saloons were generally flanked on both sides by state-rooms. This not only shut out the air and light from them in great measure, but also compelled those of their occupants on Neptune's free list to be unwilling auditors of the groans and other distressing noises made by those from whom he was exacting his dues.

The older lines now remedied these evils by adopting the plans of the new ships, in which the saloons were amidships where there was the least motion, and ventilation was perfected in their cabins and saloons by ingenious contrivances.

For ventilating purposes, for example, on the *Germanic*, there were shafts communicating with the saloon and staterooms, and in fact with all the passenger compartments, through which warm and cold air could be driven by a fan. The advantages of this contrivance over that of opening or shutting the ports, hatches, and skylights must be obvious, and especially in stormy weather, when these inlets and outlets of fresh and foul air are required to be kept closed.

The saloons on the White Star ships were not only improved in comfort by being placed amidships, but were in advance in their internal arrangements of any accommodation hitherto provided for cabin passengers. That, for example, of the *Germanic* was a magnificent apartment 52 feet 9 inches long by 42 feet 6 inches, the full width of the ship, in breadth, and nearly 8 feet in height. The tables were placed lengthwise, and could seat 200 people for meals at the same time.

The old seats were benches with movable backs, which made it difficult to get into your place if that was not at one end of them, and difficult to get out of in the case of a well-understood emergency. These were now replaced by revolving chairs, which obviated these difficulties. All the furniture, chairs and other seats, were of teak, and covered with crimson velvet. The panelling round the saloon was of beautifully polished bird's-eye maple, with fluted teak columns picked out in gold, and the walls were covered with neatly embossed and waterproof papier-maché.

The flooring in the former was in parquetry, composed of oak, teak, and walnut, and handsomely carpeted. A gay and cheerful aspect was given to the saloon by the decorations of the walls and the great quantity of glass of various shapes and colours on the silvered racks which depended from the ceilings over the tables, while a homely feature was given to the apartment by a well-appointed fireplace, a handsome piano, and an attractive, well-filled library of books.

The smoking-room, situated at the top of the spacious staircase leading from the saloon, was, with its comfortable lounges with supporting arms, and its marble-topped tables, a most attractive resort. The ladies' saloon, the most luxuriously fitted-up apartment in the ship, was placed on the promenade deck, where in either foul or fair weather it afforded a comfortable and pleasant resort.

The state-rooms, some of which were large enough for a family, were placed fore and aft of the saloon. Two of them had swinging berths, on the Bessemer principle, on a small scale. Being an excellent counteractive to the rolling and pitching of the ship they were a great comfort to timid or sea-sick ladies.

Lavatories and closets on the best principles of construction were numerous. Even the luxury of a barber's shop, of itself quite a sumptuous institution, was provided.

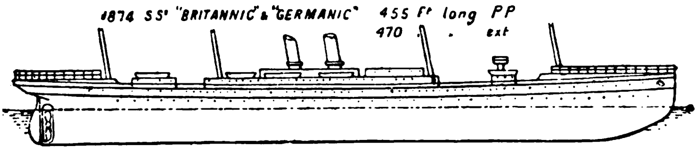
To this enumeration of luxuries and comforts we must add a hospital and other special accommodations for steerage passengers. In fact, these Belfast ships did for travellers by our ocean railways that which Pullman's sleeping and palace cars did for the comfort of passengers by our land lines.

Attention was, however, also practically called by the builders of the *Oceanic* to the importance of strengthening the hulls of iron vessels by the continuous iron decks with which they had supplied her. Instead of planking over the iron beams, as was the general practice previously, the decks were formed by iron plates as strongly riveted together as were those in the hull of the vessel.

The case of the unfortunate *Atlantic*, which was inexcusably run upon the rocks by her captain in April, 1873, off Sambro, N.S., is in point here. There can be no doubt that, but for the strength given to her hull by these continuous iron decks, not a soul would have been saved from her wreck.

Unfavourable criticisms were at first made upon the want of breadth of beam in the first White Star ships as compared with their great length. This, it was maintained, would prevent their being good sea boats. Although the results of their performances in heavy weather on the Atlantic have contradicted this conclusion, we only remark in passing that the disproportion referred to was more apparent than real, owing to the peculiar shape of their bows. The lines of these vessels from the stern were so modelled as to give the ship very stiff bearings. Their clearance lines were shorter than usual, giving a practical correction of the once popular theory that for speed these lines should be elongated up to and beyond the centre of the vessel.

Their bows were of a different shape to those of the older steamers, as will be noticed in the following woodcut of one of them drawn on the same scale as the other similar illustrations which are to follow:



We have on several occasions watched how a White Star steamer behaved in a head sea. At first it seemed as if she was about to run into it, but when it began to rise just above the level of the bow end of her forecastle turtle-back, the ship sprang up and rode the wave like a duck. In a beam sea the rolling of these vessels was as easy as that of sailing ships with well-stowed cargoes on board, for there was absent that unpleasant jerk so common in steamships on rolling when they came to their bearings.

CHAPTER XI.

Sketch of the rapid increase in the size of ocean steamers and the marked acceleration of their speed under the impulse of keen competition between rival lines.

WHEN referring to the size of the *Great Eastern* on a previous page, it was remarked that Brunel's idea of large ocean steamers was right, and that he only failed in carrying it out from want of power to propel his big ship. The present era fully confirms his views, for as the power of the steam-engine has been increased and the screw propeller improved, we have *pari passu* with this increase and improvement been gradually increasing the size of our ocean-going steamers.

The first striking advance in that direction was made by the White Star Line, for the Cunard steamer *Scotia*, built in 1862, and considered in her day a leviathan, was but 379 feet long. The *Oceanic*, built of iron in 1870 by Messrs. Harland & Wolff, was, however, 420 feet in length. The former measured only 2,358 tons, while the latter had a measurement of 3,707. There was also a marked difference in the engine power, coal consumption, and speed of these boats. For example, the *Scotia's* engines were on the old-fashioned principle and of 1,000 horse-power nominal, while those of the *Oceanic* were on the compound principle and of 3,500 indicated horse-power. The consumption of coal of the former—a paddle-wheel steamer—was from 150 to 180 tons per day, while that of the latter was only 95 tons a day. In 1870, however, the Cunard Company, following the example of the builders of the White Star ships, introduced the new fuel-saving engines.

The average speed of the *Scotia* was 13·9 knots or 15 statute miles an hour, and that of the *Oceanic* was 15 knots or 17¼ statute miles. Before the appearance of the White Star steamers the average passage between Queenstown and New York had been from 9½ to 10 days, but was reduced by them to from 8 to 8½ days.

In 1873 the Inman Line added to its fleet the *City of Rome*, 440 feet long, and measuring 4,780 tons burden. She was fitted with engines of 700 horse-power nominal, and her speed on trial was 17¼ miles an hour. Her quickest run from Queenstown to New York was 7 days 18 hours 50 minutes. Her owners, however, not satisfied with her performances, returned the vessel to her builders as not up to the terms of their contract.

The *City of Berlin* of the same line, brought out in the following year, was 488 feet long, and measured 5,526 tons. She was fitted with engines of 1,000 horse-power nominal, and made a run between the ports named in 7 days 14 hours 12 minutes. This feat, with her extreme comparative length and sumptuous fittings, excited much surprise and admiration at the time.

In the same year the White Star Line added the *Germanic* and *Britannic* to their fleet. They were 455 feet long, and measured respectively 5,008 and 5,004 tons burden. Their engines on the compound principle indicated 5,400 horse-power, and their speed on trial was 16 knots or 18·424 statute miles an hour, but which they exceeded on several voyages.

The quickest trip of the latter between Queenstown and New York in 1877 was made in 7 days 10 hours 50 minutes, or in three hours less than the fastest trips of the vessels of the other competing lines. The passage across the Atlantic was thus brought nearer to a period of seven days. But in 1891 this steamer came nearer to that limit by making a passage across it in 7 days 6 hours 55 minutes, her average speed being 16·08 knots per hour. Her sister ship, the *Germanic*, steamed from New York to Queenstown in August, 1891, in 7 days 7 hours 37 minutes, or at the rate of 16·10 knots per hour.

These results, it must be remembered, were given by ships eighteen years old, of large carrying capacity, and fitted with compound engines, and on a comparatively small coal consumption. For five years these vessels were the crack steamers of the Atlantic.

In 1879 the Guion Line entered into competition with them for this honour by adding the *Arizona* to their fleet. She was 450 feet long, and measured 5,164 tons, and her engines were 6,300 indicated horse-power. Her speed on trial was 17 knots or 19½ statute miles per hour, and her quickest trip from Queenstown to New York was made in 7 days 3 hours, or nearly eight hours less than that of the *Britannic* in 1877.

The Cunard Company, which had been jogging along on its old lines of watchful carefulness, was at last roused to action by the dashing enterprise of its competitors in the Atlantic trade, and in 1881 added the *Servia* to their fleet. This new ship was 515 feet long, and measured 7,392 tons burden, and was fitted with engines indicating 10,300 horse-power. On her trial trip her speed was only 16·9 knots or 18½ miles per hour. Her quickest trip, however, to New York from Queenstown was made in 6 days 23 hours 50 minutes, thus reducing the voyage across the Atlantic by 9½ hours.

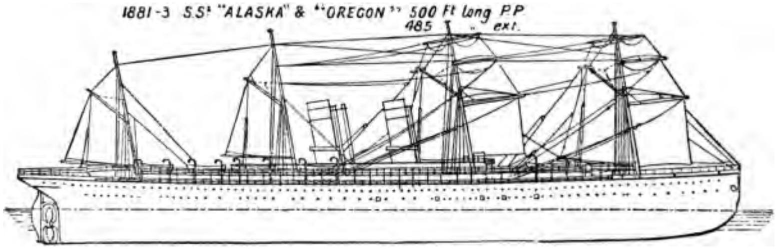
The Inman Line now followed in the same year with a new *City of Rome*, much larger than the former discarded vessel, her length being 542 feet, and her measurement 8,144 tons. The engines with which she was fitted were the most powerful yet built, for they were of 11,890 indicated horse-power. Her speed under trial was 18·23 knots or 21 statute miles an hour, and her quickest run to New York was made in 6 days 21 hours 4 minutes, thus reducing the voyage across the Atlantic by 2 hours 46 minutes.

The draught of a vessel with other considerations must be taken into account in judging of her speed. It is interesting, therefore, to notice this with respect to the steamers mentioned as having been built after the *Scotia*; she drew 22 feet when ready for sea. We have no record at hand relative to the draught of the *City of Rome* and the *City of Berlin*. The *Germanic* and *Britannic* and the *Servia* drew a fraction over 23 feet, although the latter was 2,380 tons larger than the former. The *Arizona* drew only 18 feet, or five less than the *Germanic* and *Britannic*, although she exceeded them in size by 160 tons. That of the new *City of Rome* was but 21 feet, though she exceeded the *Servia* in size by 752 tons and each of the White Star ships by 3,140 tons.

It is also interesting to notice another important sign of progress in engine power in these vessels. The pressure in the cases of the *Germanic* and *Britannic* was 70 pounds to the square foot, but which was increased in the *Arizona*, *Servia*, and *City of Rome* to 90 pounds to the square foot, and in the *Alaska* and *America* to 100 pounds to the square foot.

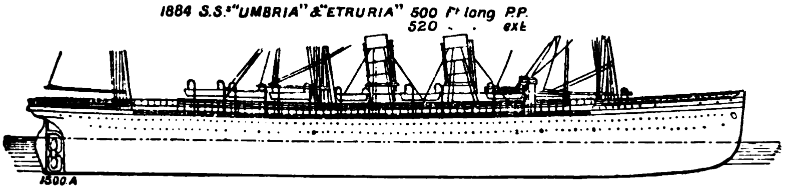
The *Alaska*, built by the Guion Line in 1881, was 500 feet long and measured 6,932 tons. Her engines were of 10,000 indicated horse-power, and on her trial trip she showed a speed of 18 knots or 20¾ statute miles an hour. She further reduced the voyage across the Atlantic by 2 hours 27 minutes, having made her quickest trip from port to port in 6 days 18 hours 37 minutes.

Public attention now became interested in the race between the rival ocean railway companies, for no sooner did one line establish a "Flying Scotsman" than the other started, like our land lines, a "Flying Dutchman" to beat it. The *Alaska*, from her swiftness, was called, in Americanese, the "greyhound" of the Atlantic. But soon her record was broken by the *America*, of the National Line, built in 1883. She was 432 feet long, 5,528 tons burden, and on her trial trip steamed 17·8 knots or over 19½ statute miles an hour. This new "greyhound" reduced the Atlantic voyage by 4 hours 19 minutes, having crossed from port to port—Queenstown to New York—in 6 days 14 hours 18 minutes. As her draught was 26 feet, this performance of the *America* must be regarded as very remarkable. Although she was 1,000 tons less measurement than the *Alaska*, and 68 feet shorter, her breadth of beam was a foot greater and six feet over that of the *Germanic* and *Britannic*, although her length fell short of theirs by 23 feet, with only 500 tons greater measurement.



We come now to the *Oregon*, added in the same year to the Cunard fleet. Her length was 501 feet, breadth 54 feet

2 inches, and of 7,375 tons measurement. She was fitted with engines of 13,000 indicated horse-power, with a boiler pressure of 110 pounds to the square inch. So far as power was concerned, this was an advance of 1,400 horse-power over the engines with which the *City of Rome* had been fitted, and 1,000 horse-power over those of the *Servia.* Her trial speed was 18·3 knots or 20¾ statute miles per hour, and her quickest passage to New York was 6 days 9 hours 51 minutes, thus reducing the voyage across the Atlantic by 4 hours 23 minutes. This noble ship was run into and sunk on her last voyage to New York by a vessel laden with coal. That she would have floated is almost certain if one of the doors between two of her compartments had been closed. Unfortunately, this door, at the time of the accident, was blocked by coal, owing to the neglect apparently of the stokers. Captain Cottier, who, by his coolness after the accident occurred, saved her passengers and crew, was held responsible by the Company for this failure, and discharged from their service.



In 1884 the Cunard Company added the *Umbria* and the *Etruria* to its fleet, each being 501 feet 6 inches in length, with 57 feet 2 inches in breadth of beam, and measuring respectively 8,128 tons. Their engines were the most powerful triple expansion engines yet built, as each indicated 14,320 horse-power. Their boilers were worked at a pressure of 150 pounds to the square inch. On their trial trips both vessels showed a speed of 19 knots or 21·849 statute miles an hour.

The quickest passage of the *Umbria* from Queenstown to Sandy Hook was made in 6 days 3 hours 4 minutes, and that of the *Etruria* in 6 days 1 hour 50 minutes, or eight hours shorter than the quickest run of the *Oregon.*

Four years later (1892) the International Steamship Company (Inman Line) added to its fleet the *City of New York* and the *City of Paris.* They were built by Messrs. J. & G. Thomson, Clydebank, under the following contract conditions with the owners:

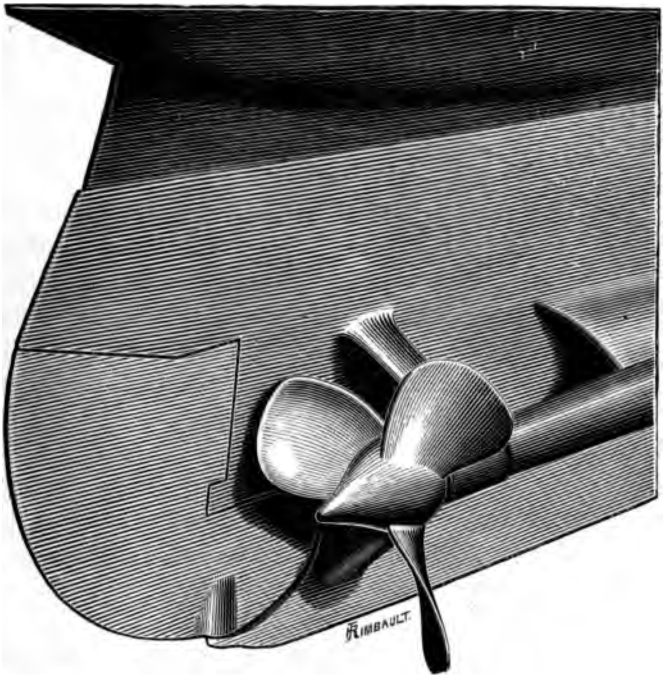
First, The ships were to be so constructed as to prevent them sinking under any circumstances which human foresight could provide against. Second, Their accommodation for first-class passengers should be so arranged as to combine "the comforts of home with the richest luxuries of hotel life." Third, That both vessels should be provided with such propelling power as would give them a speed under steam of not less than 20 knots an hour.

The builders did their work so well that when the vessels were completed they were rightfully regarded as eclipsing in size and engine power all their predecessors, and were also credited with being the first Atlantic liners fitted with twin screws.

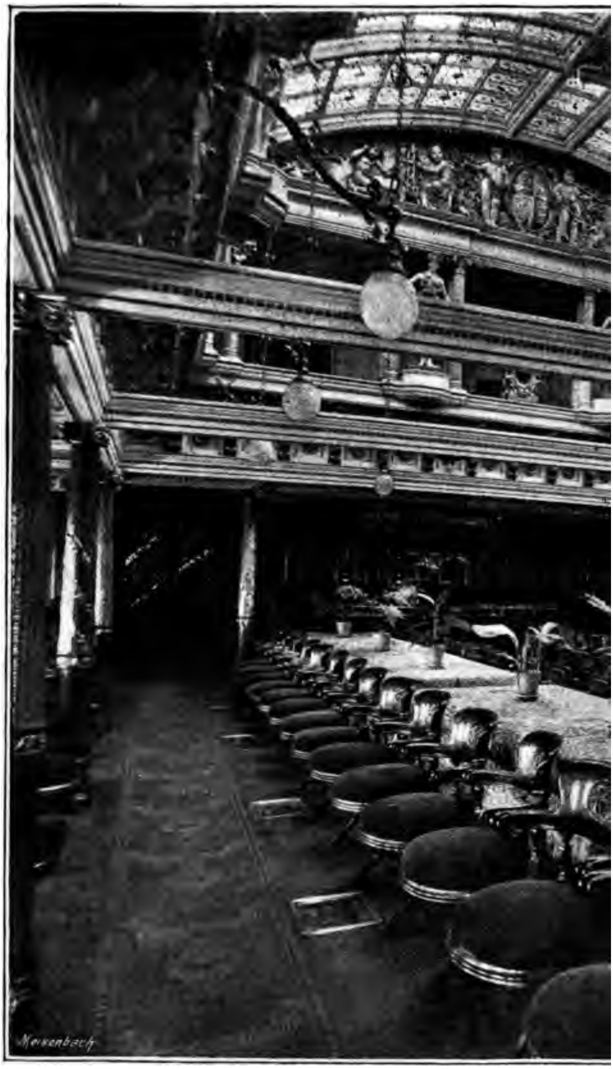
Their dimensions were as follows: Length over all, 560 feet; length along water-line, 525 feet; beam, 63¼ feet; moulded depth, 42 feet; measurement, 10,498 tons gross.

As these vessels were designed to be propelled by twin screws, they were each fitted with a pair of independent triple expansion engines, those on the *City of Paris* indicating 18,400 horse-power, and in her sister ship 20,100 horse-power. Their boilers are worked at a pressure of 150 pounds to the square inch, and there are nine in each ship, consuming 320 tons of coal a day, or at the rate of 13⅓ tons shovelled every hour into their furnaces.

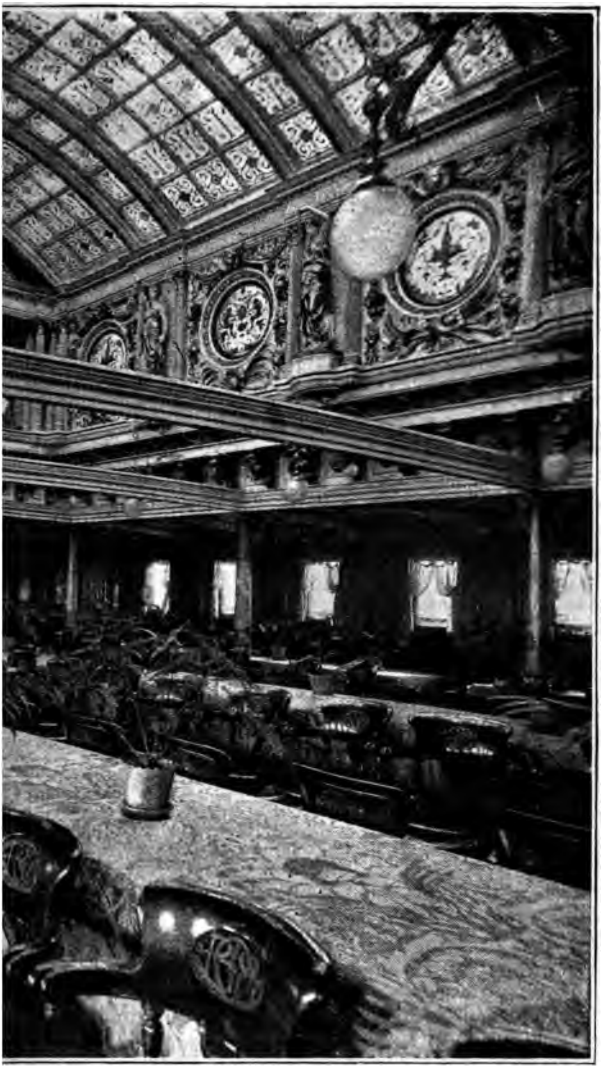
The fitting of these vessels with twin screws marks a new era in ocean steaming, for they are the first Atlantic liners in the propulsion of which this system has been adopted. The advantages of being propelled by two screws worked independently of each other, instead of by one screw, are obvious. If one of the former should be injured or its engine break down, as was the latter case in a voyage home of the *Paris*, the ship can still be propelled, though at a slower speed, by the other



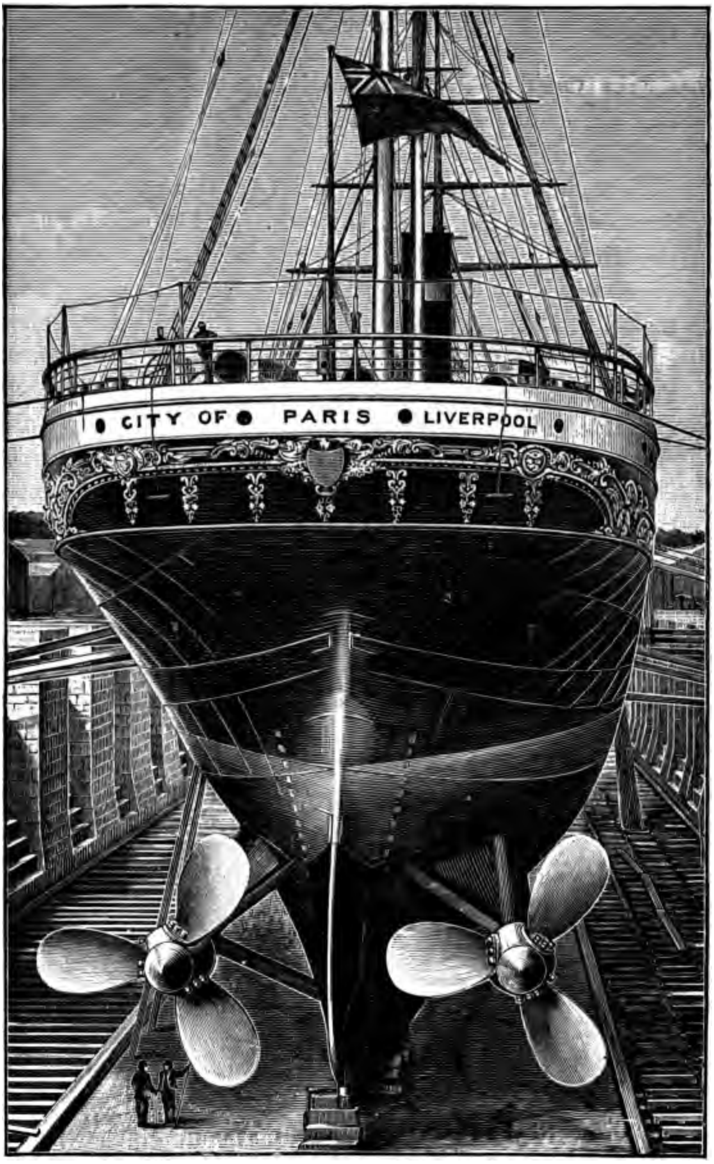
Showing Rudder of Steamship *New York.*



DINING SALOON of ORIENT



S.S. "OPHIR" (twin screw).

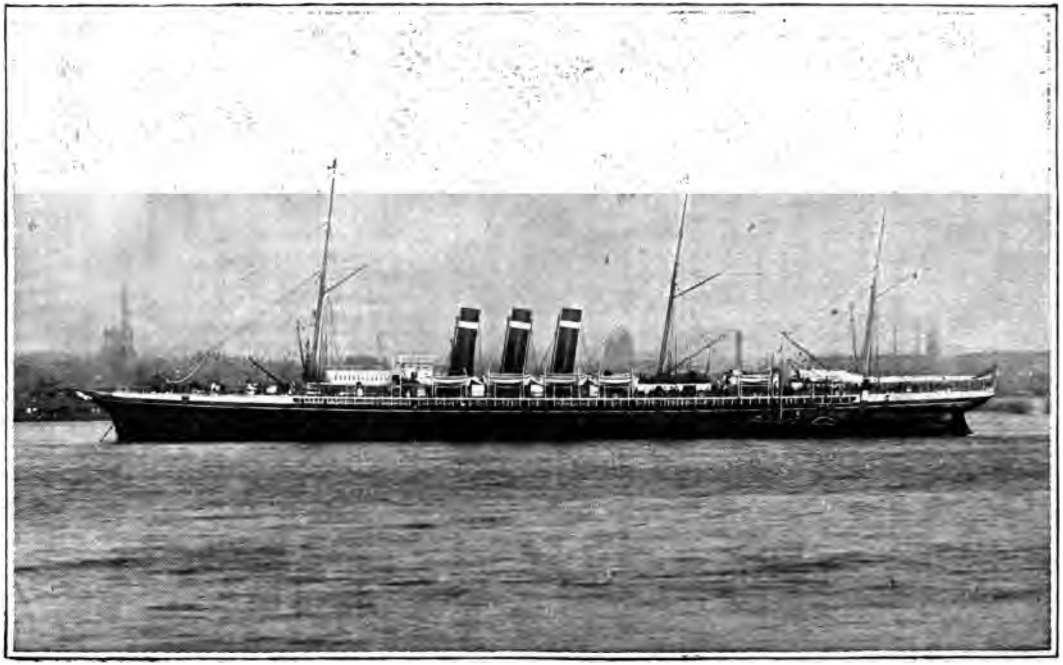


Showing Twin Screws of the Steamship *Paris.*

screw. On the other hand, as in a recent accident to the *Umbria*, if fitted with a single screw, she may be brought to a standstill in mid-ocean.

The rudders of the *Paris* and *New York* are similar to those designed by Mr. J. R. Thomson. As will be seen from our woodcut, they are formed so as to be a continuation of the hull of the vessel. Hitherto the rudders of our large steamers have been controlled by steam, but in the present case hydraulic pressure is used for the purpose on the principle introduced by Mr. A. Bells Brown, of Edinburgh. Two hydraulic rams are used, one on each side of the tiller. They supply power enough to put the enormous helm hard over when the ship is going full speed ahead, for they have respectively a normal thrust of 80 tons, but which is increased by the mechanism of the gearing to 14c tons. This hydraulic pressure is controlled by the "quartermaster" on the bridge through a tiller, which it is alleged secures greater accuracy in steering from its more direct action than if a wheel were used.

Some of the earliest designs of Woodcroft, already mentioned in connection with the introduction of the screw, were for two propellers, one on either side of the vessel under her quarters. No very great practical use was made of the suggestion until 1862, when several steamers were fitted with double screws. In 1868 three vessels of the Royal Navy were similarly fitted, and occasionally twin screws have been used in other ships. One of the principal difficulties which have delayed their adoption grew out of their having to be placed, as stated, under the quarters of vessels, for the shafts, extending some feet outside of their hulls, had to be supported by brackets which carried the bearings. In order to reduce the number of these brackets, on account of their serious drag on the vessel, it became customary to reduce the



Steamship *Paris.*

weight of the shafts by making them hollow, but of a sufficient diameter to secure stiffness. In the case of the *Paris* and *New York* the screws are supported by massive steel trusses fixed in a solid structure of cast steel, weighing no less than 26 tons. A further improvement, however, has been made in the instance of the *Teutonic* and *Majestic*, and followed in the *Campania*, as we shall presently see.

On their trial trips both vessels showed a speed of 20·13 knots or 23 statute miles an hour. The quickest run from Queenstown to Sandy Hook of the *City of Paris* was made in 5 days 14 hours 24 minutes, the distance run being 2,782 knots, and the quickest run outwards by her sister ship was made in 5 days 20 hours 39 minutes, with 3 knots additional distance. The quickest homeward voyage of the former was made in 5 days 22 hours 50 minutes, the distance run being 2,803 knots, and by the *City of New York* 5 days 19 hours 57 minutes, with 11 miles more distance.

The average of ten voyages of the *Paris* outwards was 5 days 21 hours 19 minutes, with an average distance run of 2,815 knots, and of ten homeward voyages, 6 days 5 hours 34 minutes, with an average distance run of 2,842 knots. The average of ten voyages of the *New York* outwards was 6 days 4 hours 45 minutes, and the average distance run 2,819 knots, and for ten voyages homeward-bound 6 days 3 hours 5 minutes, with an average distance of 2,856 knots. Ten of the passages of the two steamers were accomplished under 6 days, the average of them being 5 days 20 hours 10 minutes.

The daily runs of the *Paris* on her quickest outward trip maintained a speed throughout the entire voyage of $20\frac{7}{10}$ knots an hour, logging one twenty-four hours no less than 530 knots, or 610 nautical miles!

The *New York* left Sandy Hook on August 17th at

3.20 p.m., and arrived at Queenstown at 4.17 p.m. on the 23rd, having thus accomplished the voyage in 5 days 19 hours 17 minutes, the quickest east-bound trip yet made by any steamer up to that date. Her average speed was 20·10 knots or a small fraction over 23 statute miles an hour.

Both vessels have the American clipper ship bow, with a short bowsprit, and an overhanging stern. They thus differ, and we think favourably, in appearance from the straight-stemmed and flat, round-sterned fashion for steamers which has come into vogue of later years. The latter seems to us as if crop-eared, close-shaven, and too full of fight and masculine in appearance to suit the soft designations of "she" or "her," excepting in an Amazonian sense. The admirers of the latter style, however, defend it by alleging that as steamers are built to battle with and tear their way through the stormy waters of the ocean, there can be no objection to the combative aspect they are thus made to assume.

CHAPTER XII.

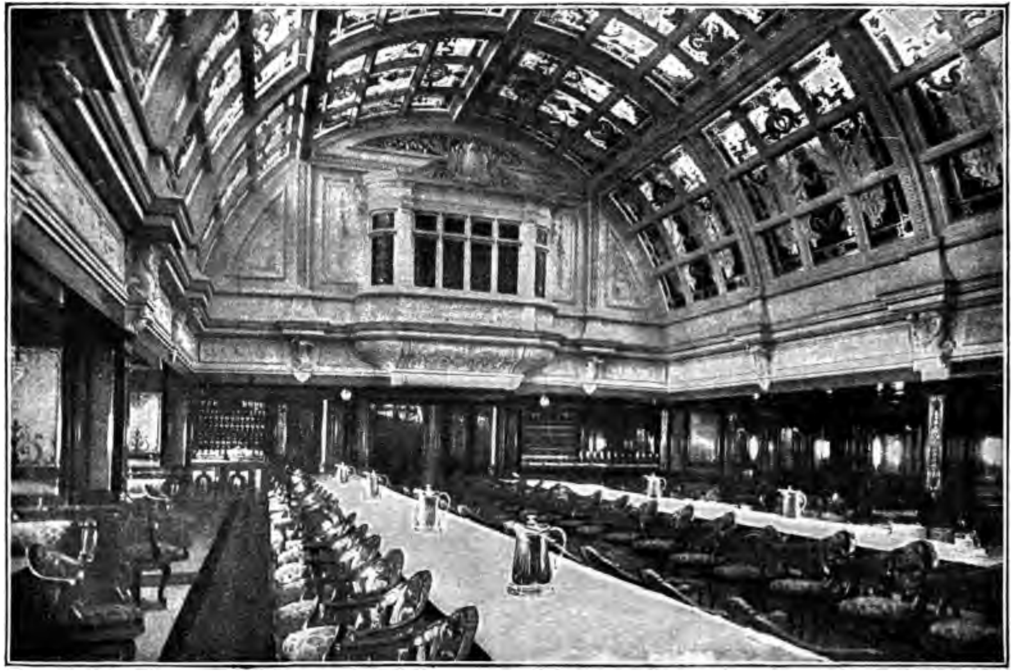
The winners *pro temp.* of the blue ribbon of the Atlantic described externally and internally, and observations on their change of flag.

SPECIAL care was taken by the builders to prevent the vessels sinking, for each of them has fifteen watertight compartments, separated by strong transverse bulkheads. These rise up from the keel to the saloon deck, or 18 feet above the load water-line. They have no openings of any kind through them, so that in case of accident no aperture remains open that ought to be closed, as in the case of the ill-fated *Oregon*, and nothing is left to be done in order to save the ship in a time of danger or in a panic.

The buoyancy secured by this subdivision of the hull of the vessel is so great, that even if three compartments were filled with water through a collision the vessel would still float. If the ship also struck a ledge of rocks when under way and tore a hole a hundred feet long in her bottom, or a rent that length under water through one side of her hull, the vessel could safely continue her voyage.

Three of the watertight compartments are set apart for the boilers, and one for the engines, which are separated by a longitudinal bulkhead, thus duplicating the ship's machinery.

The saloon passengers are housed in the three central



Grand Saloon of Steamers *Paris* and *New York.*

watertight compartments, two abaft these are set apart for the second-class passengers, while those at each end are devoted to the steerage and cargo.

The first-cabin saloon is situated on the forward saloon deck, and is 53 feet long and about the width of the ship. The arched form of its roof (not ceiling), with its Crystal Palace central nave-like centre, gives it an imposing appearance. Its height from the floor of the saloon to the crown is 20 feet, and the length of the arch is 53 feet, and its span 25 feet. Accommodation was originally provided in it for 260 passengers, but by the addition of a saloon amidships, 420 persons are enabled to dine at the same time.

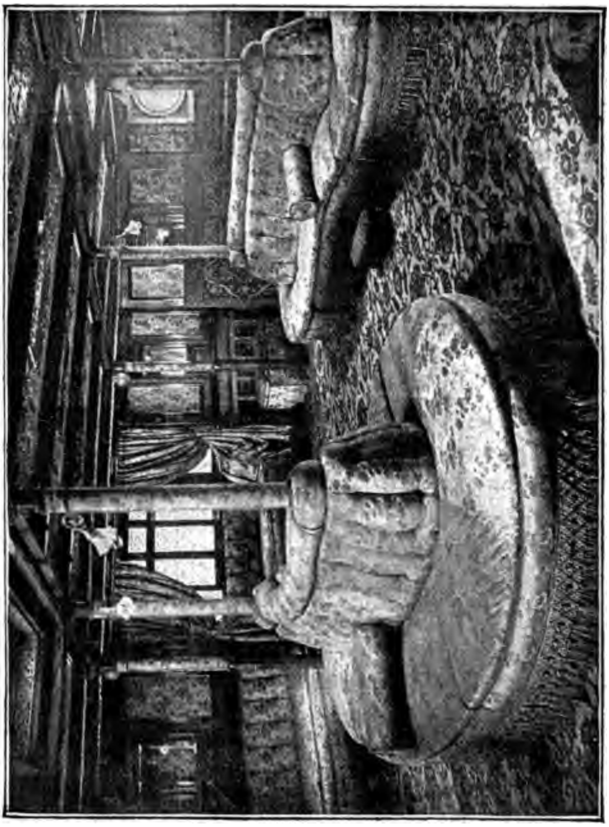
The artists in decorating the saloon have brightened its panelling by representations of naiads, dolphins, and tritons, and other mythical members of Neptune's court, including mermaids in the form of intermediate brackets.

Besides the two long public dining-tables in the centre of the saloon there are a number of smaller ones, designed for the use of families or parties of friends. These are cosily placed in alcoves on both sides of it, and are prettily decorated by oak wainscoting and maple lintels.

These alcoves somewhat detract from the appearance of the saloon by apparently reducing its size. At night it looks its best under the brilliant illumination of its numerous electric lights reflected from scalloped shells of burnished brass.

Besides the saloon there is the drawing-room, elegantly decorated and luxuriously furnished. The "library," with its 900 volumes, is lined with an oaken wainscot, with the names of distinguished authors carved on it in scrolls, and by a quaint fancy, quotations from poems referring to the sea are inscribed upon its stained-glass windows.

Then there is the smoking-room, 45 feet long, with accommodation for 130 smokers at a time. Its walls and ceiling are panelled in American walnut, and its couches and chairs are covered with figured scarlet leather. At one end there is a large bar for its frequenters.



Drawing-Room of Steamers *Paris* and *New York*.

As the promenade deck extended almost the whole length of the ship, it was consequently likened by a New Yorker to a public park.

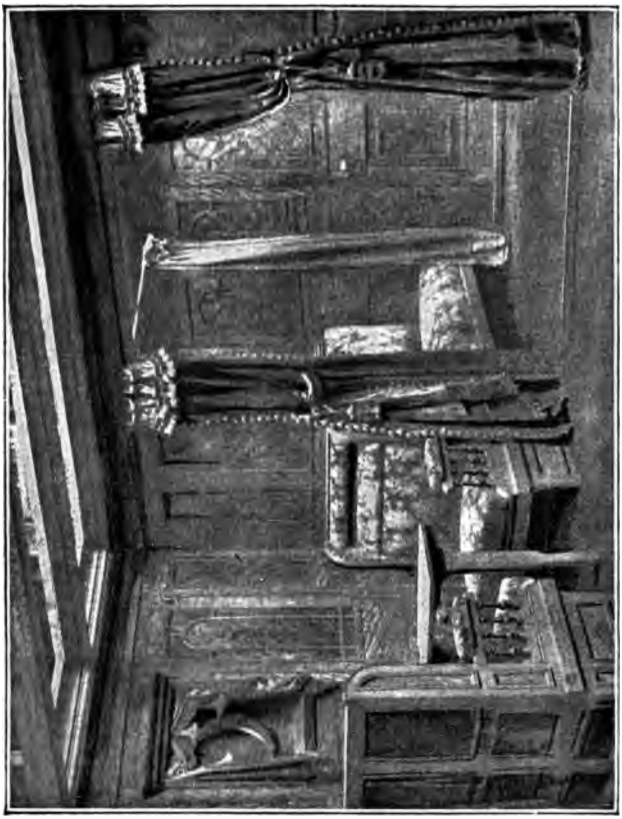
The chief kitchen on the main deck under the grand saloon is entirely isolated in a steel shell, without any aperture excepting the ventilating shafts which lead into the funnels of the steamer. It is, therefore, out of sight, smell, and hearing. Lifts worked by hydraulic power carry the cooked dishes into large pantries off the saloon, from which they are served by the stewards. The same arrangements exist in the case of the second cabin saloon.

The second cabin passengers have a piano, a smoking-room, and about 100 feet in length of the after-part of the ship, and well protected from the weather by the houses forward of it and a canvas roof, as a promenade.

The first-class state-room accommodation is sumptuously comfortable. Upon the promenade and saloon decks there are forty of these rooms, arranged in fourteen suites. Of one of them, shown at the Glasgow Exhibition, which excited general admiration, we give an illustration. Each of these suites comprises a bedroom, sitting-room, private lavatory, and, in most cases, a private bath. The bedrooms are fitted with single and double beds in berths which, as in a Pullman car, are closed by day.

As already stated, emigrants were first conveyed across the Atlantic by this line. It is natural, therefore, that we should expect to find ample accommodation in these steamers for that class of passengers. Out of the million cubic feet of space available on each of them, 300,000 feet is occupied by cargo, 400,000 feet are allotted to the saloon and second cabin passengers, the remaining 300,000 feet being devoted to those of the steerage.

Besides the large propelling engines, there are a number of smaller ones used for various purposes. The rudder, for example, with a surface area on one side of 250 square feet, is controlled from the bridge by hydraulic power through rams worked by a steam-engine. These smaller engines are all duplicated, and are noiseless when in motion, a desideratum which passengers will appreciate.



First Class State-Room *en suite.*

Another of the novelties introduced into ocean-going steamers in our day is the electric light, doing away with the old oil lamps often inconveniently turned off at 11 p.m. The dynamos on these vessels are of extra power, for they generate a current powerful enough not only to light up the ship everywhere, but also to rotate the fans employed in ventilating her. Thus 250,000 cubic feet can be drawn off from each compartment per hour by its use.

Before closing our concise description of these floating palaces, we must call attention to another novelty in their design calculated to render more impressive the religious services held on our large ocean steamers on the Sabbath.

At each end of the saloon, as will be seen in our woodcut, there is an oriel window built under the glass dome over the dining saloon. The casement of one of these serves for a pulpit, and the saloon as the nave and transept of the *pro tempore* church. The other opposite to it in the other gable is a veritable organ loft, for there is an organ in it. Since these ships have been running, many famous organists and vocalists have taken part in the Sunday services held on them. Much charitable help has also been given to worthy objects from time to time, as the result of musical entertainments given on week-days. Madame Adelina Patti, who has only once sung at sea, gave her services on such an occasion on the *Paris*.

These noble ships of British design and construction no longer fly the flag under which they first sailed, for instead of the Union Jack they now carry as their national ensign the Stars and Stripes. They have, however, thus become actually what they were previously nominally, for the majority of the shareholders in the International Navigation Company were New York and Philadelphia capitalists.

Both vessels have passed from the British to the United States Register under an Act of Congress approved on May

10th, 1892, and their services as armed cruisers were by it also transferred from England to the United States.

In the discussion on this bill a senator said "that these two ships could escape from any war vessel afloat, and could destroy any merchant ship on the seas." And this was the ground upon which our Government had already subsidised them at the rate of £26,000 a year. When it did so it informed their owners that as in the case of trouble the United States were likely to ask them for these ships, there ought to be a penalty attached to this subsidy convention, and it was agreed that there should be always one year's pay held in arrears by the Government, and that this sum should be the penalty if the ships were transferred to the United States Register.

The steamers under the American flag are to be excluded from the United States coasting trade, but, under the Act authorising the transfer, may be used either by charter or purchase by the United States Government, as cruisers in case of war. Nor will they be entitled to a subsidy under it, as they are British and not American-built. The owners are, however, bound to construct two or more vessels of a similar capacity in the United States and under the same conditions.

Two other ships of 12,000 tons each, and of the same type and power as the *Paris*, have been laid down in the ship-yard of Messrs. W. Cramp & Son, Philadelphia. Until ready for service their places will be taken by the British-built steamers *Chester* and *Berlin*, so that one half of the fleet of the new American line will sail under the Union Jack and the other half under the Stars and Stripes.

We, the inventors of the steam-engine, and the first to use it as a propelling power both on land and water, instead of being dissatisfied at the transfer to our kinsmen across the

Atlantic of British-built ships, have reason rather to be pleased at having supplied them with such magnificent models of our engineering and marine skill. And although the *Paris* and her sister ship are fitted with powerful electric search-lights in view of their possible employment as armed cruisers, and have otherwise been adapted for such a service, we have also good grounds for the conviction that they will never be used against us for that purpose. Had they passed into the hands of an unfriendly foreign Power the case would have been entirely different. We cannot, however, regard the people of the United States as being included under either of these categories. They are not foreigners to us in the sense in which this term is generally used, but our kinsmen.

We cannot refrain in this connection from recalling the following interesting incidents which occurred when our relations with the United States were strained to the utmost tension through complications growing out of the war between the North and the South. During a serious period of that crisis the daughter of General Schenck, then American Minister to England, when asked who had been at a large social gathering she had attended in Paris, replied: "Oh, there were present English and Americans and a lot of *foreigners*!"

The late Henry Ward Beecher, when addressing a large political meeting at New York, rebuking the belligerent spirit aroused in some classes of American society by our demand for Mason and Slidell, taken from a British ship by an American war-vessel, said that there was "too much Bible in both countries to allow them to go to war with one another!"

CHAPTER XIII.

Belfast turns out the two first mercantile armed cruisers, with a description of their hulls, engines, twin screws, and palatial passenger accommodation.

We come now to another great advance in several important particulars in the construction of ocean steamers by the addition to the White Star Line fleet of the *Teutonic* and *Majestic* in 1889–1890.

The designs for these magnificent ships were prepared by Sir Edward Harland as long ago as 1880, but the owners did not proceed with their order until obliged to do so to prevent the White Star Line falling behind its competitors.

Before, however, orders were given for their construction negotiations were entered into by the Company with the Admiralty for the special construction of the projected steamers as mercantile armed cruisers.

The *Teutonic* was launched in January, 1889, twenty-two months after her keel had been laid, but did not take her place in the fleet until the following August. Her dimensions are as follows: Length, 582 feet; breadth of beam, 57 feet; and depth of hold, 39 feet 4 inches, and she measures 10,000 tons. She is fitted with triple expansion engines, one for each screw, of 17,000 indicated horse-power. Her sister ship, the *Majestic*, of precisely the same dimensions, was launched in June, 1889, but did not take her place in the fleet until April, 1890.

The manner in which the hulls of these vessels have been put together is not only novel, but marks a great improvement in marine naval construction so far as increased strength is concerned. In the first place the plates used for their outer shells are of unusual dimensions, being three feet in width, and many of them from twenty-four feet to twenty-eight feet in length, dimensions not possible if steel had not been used in making them. Instead of being put together end to end and butt-riveted, they are laid on the steel frame so as to overlap each other vertically or in a thwart-ship direction, and then trebly, quadruply, and even quintuply riveted together. In fact, unless welded to each other, the plates of the hull could not be more compactly united.

The vessels have each four decks, made by covering the strong steel beams with plates of the same material trebly riveted together. In addition to the seventeen transverse bulkheads which hold the sides of the vessel in a rigid grip, there is a longitudinal bulkhead running through the centre of the ship for three-fourths of its length from the stern-post, and rising from the keelson to the main deck, which, like a huge backbone, locks all the parts of the hull together. It does seem, in view of these constructions, external and internal, that it would surpass the wit of man to make hulls stronger and stiffer than these have been made by Messrs. Harland & Wolff.

The twin screws with which the vessels are fitted overlap at the tips, the starboard screw being carried some feet further aft than the other in order to get clearance. No outside stern tubes, in the proper acceptation of the term, are used, for the propeller shafts are carried out in what are really protuberances of the hull in the run of the vessel. At the extreme end, especially of the starboard tube—which, as stated, is carried furthest aft—the formation almost approaches a complete circle, the attachment to the ship being by a double web of plating.

The stern frame of the vessel is built up of five steel castings, and the stern-post is cruciform in shape. The propeller shafts are sixteen feet from centre to centre apart, allowing nineteen feet for the diameter of propellers, the overlap being five feet.

The two sets of engines on the *Teutonic* are not only divided from each other, but according to the requirements of the Admiralty are placed well below the water-line. This not only well protects them from the shots of an enemy in case of being employed in war, but with the great solidity of the hull will free passengers from the consciousness of their existence when in motion.

In responding to a toast after dinner on the *Teutonic*, when on her trial trip, Sir Edward Harland declared that his firm had not only been put on their mettle but upon their honour in her construction, for they had received absolutely a *carte blanche* from her owners as to cost.*

Mr. A. B. Forwood, who was present, speaking as Secretary to the Admiralty, acknowledged that the idea of armed mercantile cruisers did not originate with the Government, but was suggested by Mr. Thomas H. Ismay, who had pointed out that in the event of the Suez Canal being closed, a vessel such as his firm proposed to build could land troops in India by way of the Cape of Good Hope almost within the same limit of time as was now required to make the passage through the Canal. "Competent experts," he further stated, "regarded the *Teutonic* as a valuable addition to the naval strength of the nation, and that no cruiser afloat could approach her in speed, and that her coal endurance was three or four times that of an ordinary war vessel." He concluded by observing that the occasion was an historical one, for the *Teutonic* was the first mercantile armed cruiser ordered by the Government.

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* Sir Edward Harland did not, however, mention the fact that all the steamers built by his firm for the White Star Line were merely ordered by their owners, and not contracted for under certain specifications, as is generally the case.

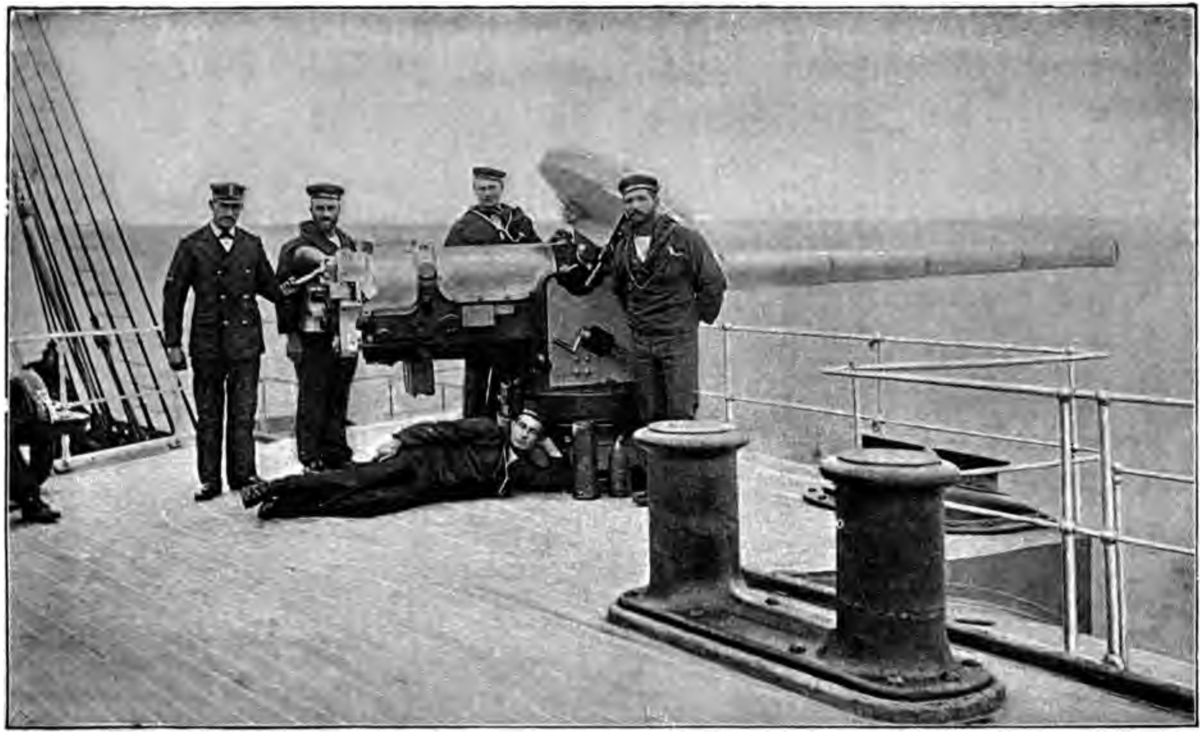
The *Teutonic* and the *Majestic* will be mounted as armed cruisers with twelve Armstrong guns, eight on the upper and promenade decks, and two each on the "turtle-backs." These guns are quick-firing, and capable of discharging twelve shots a minute, and are fitted with an oil buffer which absorbs the recoil.

The value of these vessels as troop-ships will be readily understood from the following facts.

Accommodation on each of them can be provided for 1,000 cavalry and their horses, or for 2,000 infantry. They could reach Halifax, U.S., in five days, and Cape Town in twelve and a half days. Viâ the Suez Canal they could land troops at Bombay in fourteen days, at Calcutta in seventeen and a half, at Hong Kong in twenty-one, and at Sydney in twenty-two days. Their coal supply is sufficient for seventeen days steaming at full speed, or at half speed for three months. In case, therefore, of the Canal being closed they could steam to Bombay viâ the Cape, 10,733 nautical miles, in twenty-two days without coaling on the way.

Let us now, however, regard the *Teutonic* merely as a peaceful passenger steamer, beginning with her saloon, which in size and beauty of ornamentation excels that of the *Germanic* already described.

It is 60 feet long, and 57 feet wide, or the full width of the ship. Where not covered by a crystal dome over its centre, its height is 10 feet. The decorations of this great



One of the *Teutonic's* Guns.

The vibration of either engines or screws is not sensibly felt. The ventilation of the engine-rooms and of the kitchens is carried on through a grating in the awning-deck. Thus all fumes pass away high over the heads of the promenaders, and are of no more inconvenience to them than the smoke issuing from the funnels.

The library is the only general room on the promenade deck. As its name suggests, it is fitted with book-cases containing a goodly supply of carefully selected standard works in elegant bindings, and writing-tables are arranged round it, divided by racks for stationery, which secure privacy between the writers. At each end and round it are luxurious couches.

On the promenade and upper decks there are a number of so-called special state-rooms luxuriously fitted up; some of them with double bedsteads, chests of drawers, arm-chairs, writing-tables, and couches, as if cabin space had become in this progressive age a matter of no consequence. The comfort of these rooms is rendered equal to their beauty by having the appliances for heat, light, and ventilation placed under the control of its occupant, who has but to move his hand, and his apartment is filled with light, or warm or cold air as he desires. He can look out upon the deck through his window, or by an easy movement can screen his apartment by a stained-glass blind.

The other state-rooms in the saloon and main decks are alike, some slightly larger than others, but in all their appointments are equally handsome and replete with conveniences. Even the inside state-rooms, through an ingeniously contrived miniature skylight overhead, are not the stuffy dungeons they formerly were, but are light and airy rooms.

The smoking-room is the cosiest and most handsome shrine of tobacco ever seen ashore or afloat. It is difficult to conceive such a room outside of our Pall Mall club-houses. The woodwork is of that rich dark mahogany seen in old mansions. The handsome, lazy-looking couches are upholstered with leather of a colour to match the above. The walls are covered with a richly-gilt embossed leather of the same tone. The panels are bright oil-paintings representing the picturesque ships of the Middle Ages. The ceiling reproduces a very handsome old English plaster pattern in quaint and variously shaped designs. In the daytime the room is lighted through square windows opening out on the deck, screened at will by stained-glass blinds, and at night by electric lamp in the ceiling, placed behind stained glass. Here, then, one can smoke and dream in a voluptuous corner, spanning the ages which have intervened between the times of the argosies depicted on the walls until steamships were invented, or further still, from Jason's ship to this one of the White Star Line.

As every Transatlantic voyager is aware, there is on every New York liner a barber's shop. The one on the *Teutonic* is situated in a finely-carved oak passage, the entrance to which resembles that to a vestry in a cathedral. Its fittings include even electric motors of different speeds, used to drive revolving hair-brushes and the more rapidly revolving fans for drying ladies' hair after shampooing.

The bath-rooms are both splendid and numerous, and are placed in convenient positions in charge of special attendants, and the same remarks also apply to the lavatories.

The main entrance to the saloon, and the two pairs of stairs which have to be descended in order to reach it, are parts of the ship which cannot be left out of our general description of the *Teutonic.* The vestibule, or equivalent to the old companion, the staircase, and passages are of carved oak, with white-and-gold ceilings. The vestibule is spacious and lofty, and the staircase wide and massive. All these approaches are, in short, in full harmony with the stateliness and magnificence of this magnificent ship.

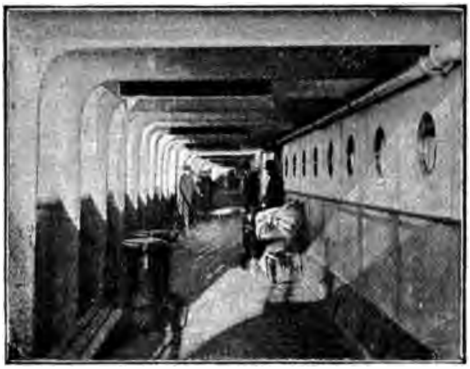
We have hitherto confined our observations to the saloon or first-class accommodation of the *Teutonic*, but our description would be incomplete if it did not include a notice of her accommodation for second cabin and steerage passengers.

The former is in the after-part of the ship, and is only recognisable as second class by a comparison of its accommodation with that of the first class. It has its saloon, staterooms, baths, and lavatories, never before associated with a secondary position of passengers on board ship. Its accommodation is so good that it will, without doubt, increase the passenger traffic between Europe and the United States by placing at the disposal of travellers who cannot afford first-class rates the great and comfortable advantages it affords. Prejudice may, perhaps, for a time debar many from using them from misconception of the term. But after inspecting what it is intended to designate, it may be asked, "Yes, second class; but with what?" Not, certainly, with the accommodation supplied hitherto by many steamship lines for their first-class passengers!

And now about the steerage, the occupants of which have stood in the same lucrative relation to the White Star Line as third-class passengers do to the Midland Railway. They have always been ranked by the former on that account as their best friends, and treated accordingly.

And this has been the policy of the Company since its commencement; in fact, the superiority of the steerage passenger accommodation on the *Oceanic* and her sister ships not only secured for them a full complement of this class of passengers, but obliged other companies to imitate them in this respect.

Still greater improvements have been made in the steerage accommodation of the *Teutonic* and *Majestic.* The whole of the free space of the upper deck is reserved for them alone, and in stormy weather they have under the bulwarks over the sixth of a mile of covered deck space provided for them, with a continuous bench running along its entire length.



Covered and Sheltered Way for Steerage.

Instead of as in the olden and more recent times, when the descent to their berthing and eating quarters was by break-neck ladders, they now reach them by wide, easy, hand-railed steps. The immense height of the vessel between decks gives her steerage passengers a large excess of cubical area over the Government requirements.

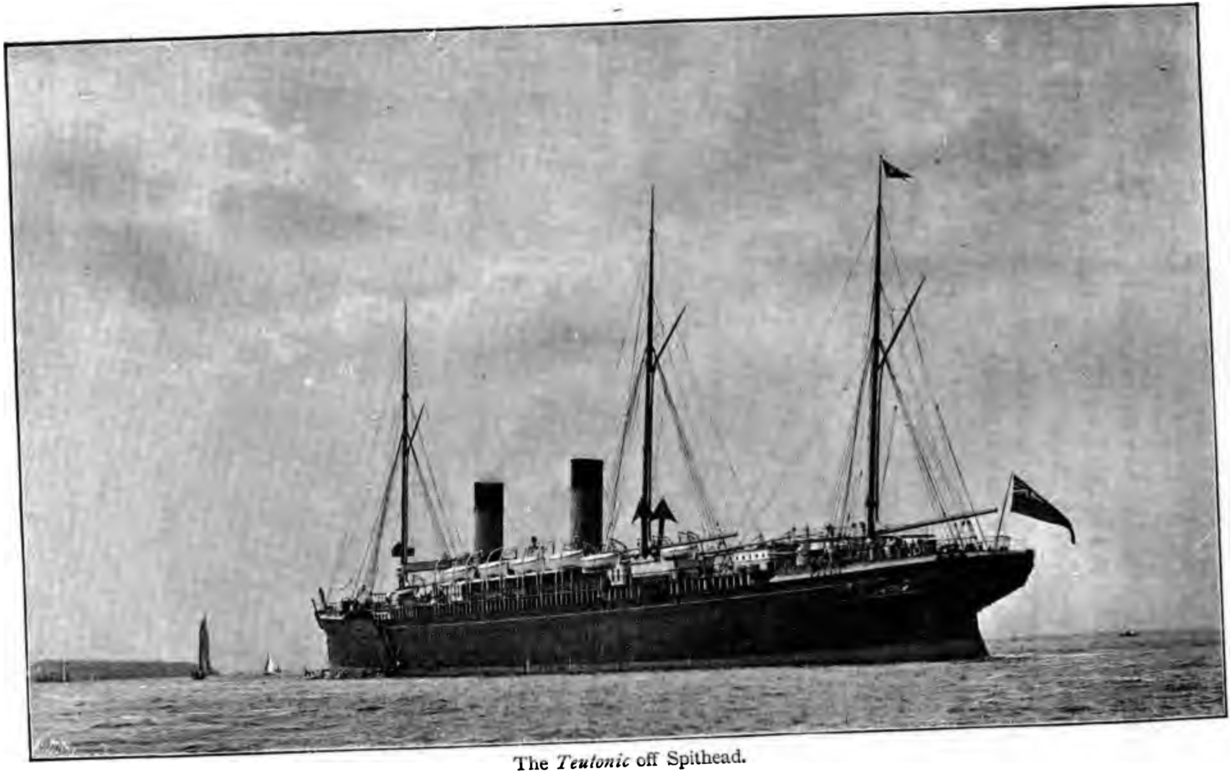
Under the forward turtle-back, next to the single men's quarters, is a smoking-room—a hitherto unheard-of luxury for steerage passengers. Adjoining the married people's quarters are bath-rooms supplied with hot and cold water. Separate rooms for families are an old institution in the provision for the comforts of their steerage passengers by the White Star Line, and, owing to her great size, those provided on the *Teutonic* and her sister ship are very much larger than in other vessels of the fleet. The unmarried women have their quarters aft and under charge of a matron.

The spaces where the tables are arranged for meals are so extensive, that a visitor to the *Teutonic* jokingly asked about one of them if it was the steerage ball-room. A profusion of electric lamps, absolutely perfect ventilation, and an elaborate system of lavatories planned with a view to the utmost delicacy, complete the merits of this ideal steerage. What a contrast does it present with that provided for the same class of passengers in sailing ships described in our earlier pages!

There are other sights in this floating palace which we have described. Amongst them are vast halls of stupendous and complicated and seemingly unmanageable machinery. There are, as it were, galleries of other machines, each plying its peculiar work of either refrigerating, dynamo driving, and so on. And there is that "Inferno," the grandest spectacle in the ship, where naught is heard but the din of raging fire and water and the clanking of ponderous iron shafts and pistons.

We must leave unvisited with regret, in this walk round the *Teutonic*, the official quarters, from the captain's elegant room in the promenade deck to the retired nook wherein the stewards when off duty make merry, as well as the large warehouses of the ship filled with cargo, and her "coal wharves" and larders of provisions.

Nor have we space to refer in detail to many things which might be added to what has been said indicative of the fitness of these sister ships for service as armed mercantile



The *Teutonic* off Spithead.

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cruisers. We may, however, thus summarise our description of them in this connection. Their engines, and rudders, and boilers are below the water-line, and, therefore, out of the way of an enemy's shot. As the difference between a war cruiser of the day—aside from armament—is a matter of engines and coal supply, we have indicated their superiority in these respects. These ships cannot—as the old Cunard liners were, for example—be regarded as mere auxiliaries to our navy, but as valuable and powerful ships calculated to discharge efficiently an important naval necessity in case of war with any Power. They, therefore, introduce the era of the real armed mercantile cruiser, which in the future will be one of the great factors in the safeguards of the commerce and prestige of the British Empire. The large amount of attention the *Teutonic* attracted at the Spithead Naval Review in August, 1889, from all classes of experts, attests her great importance in this respect. The German Emperor and His Royal Highness the Prince of Wales, who were to have visited six vessels of the fleet in the Solent, were so engrossed by the *Teutonic* that they left themselves only time to visit the flagship of the Admiral-in-Chief.

CHAPTER XIV.

The latest triumphs in steamship building over all competitors, home or foreign, and the credit due to British designers and builders.

We are now, by the recent additions to its fleet of the *Campania* and *Lucania*, brought back in the course of our narrative to the Cunard Line, the pioneer builders of our ocean railways across the Atlantic. In order more fully to appreciate this marked epoch in its history, a synoptical review of the progressive stages by which it has been reached will be useful.

It began its fortnightly mail service between Liverpool, Halifax, Quebec, and Boston, as has been shown, in 1840, with a fleet of four paddle-wheel steamers under 1,200 tons in size, and fitted with engines working up to 1,350 horse-power. These, reinforced by two others of 1,424 tons measurement and engines of 1,570 horse-power, were found for seven years sufficient to meet the existing demands of the increasing traffic both in goods and passengers.

At the expiration of this first mail contract, the Company, in order fully to meet the demand then made upon it by the Government to double the number of their sailings, added four steamers to their fleet in 1848, measuring from 1,800 to 1,900 tons, and fitted with engines working up from 1,825 to 1,918 horse-power. Two others of 2,227 tons burden, with engines of 2,350 horse-power each, were put upon the line in 1850, which were followed two years later by the *Arabia*, of 2,400 tons measurement, with engines working up to 3,000 horse-power. This vessel was supposed to have reached the greatest length desirable in a wooden vessel, although she was only 285 feet long over all. All these vessels were built of wood and propelled by paddle-wheels.

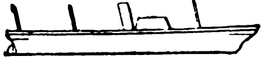
Between 1852 and 1855 five vessels of 1,400 and two of 2,241 and 2,215 tons each respectively were built of iron and fitted with screw propellers.

The relative merits of the paddle-wheel and the screw as propellers for ocean steamers had not been definitely decided upon in 1856, and we therefore find the *Persia* built of iron fitted with the former. When added to the fleet she was the largest steamer afloat, excepting the *Great Eastern*, as she measured 3,300 tons and had engines of 3,500 horse-power.

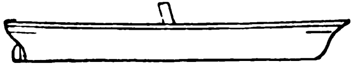
Five other iron screw steamers under 2,500 tons, fitted with engines of only 1,060 horse-power, were built primarily for the Mediterranean trade. In 1862 the *Scotia*, built of iron and fitted with paddles, was added to the Cunard fleet. She measured 3,871 tons, and her engines worked up to 5,000 horse-power. With her ended the paddle-wheel era of the Company, for all their subsequent vessels were fitted with screw propellers; for it was now experimentally proved beyond doubt that vessels could be more economically propelled at an equal rate of speed by it than by the former. For example, in 1874 the *Bothnia* was built, measuring 4,535 tons, as against the 3,871 tons of the *Scotia*, and fitted with engines of 3,000 horse-power, or 2,000 horse-power less than those of the latter.

The fast steamers of the Inman and White Star Lines, which began running in 1868–70, seemed to have roused the Cunard Line from relying merely on the deserved prestige they had acquired by the safety to passengers with which their vessels had been sailed, for maintaining their position on the Atlantic, for they added the *Gallia* to their fleet in 1879.

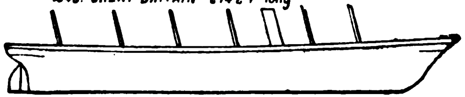
1831 "SIRIUS" 178 ft long



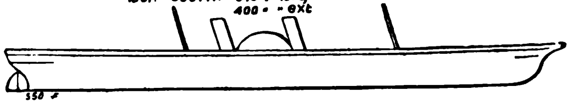
1850 "CITY of GLASGOW" 227 ft long



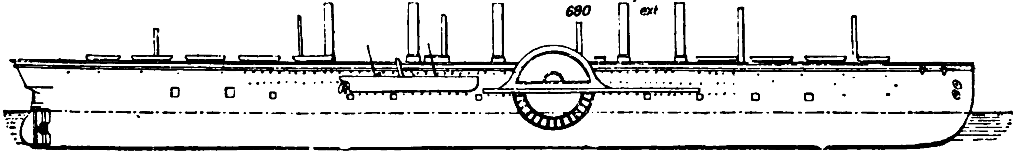
1843. "GREAT BRITAIN" 274 2 ft long



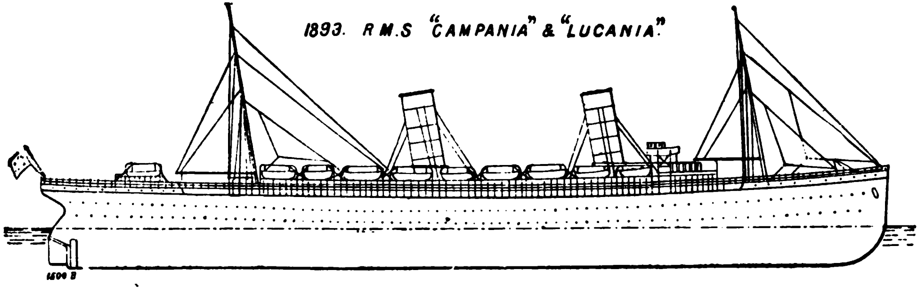
1861. "SCOTIA" 379 ft long
400 " " ext



1858 "GREAT EASTERN" 680 ft long PP.
680 ext



1893. R.M.S "CAMPANIA" & "LUCANIA".



This steamer, from her size and power, excited great attention, for she measured 4,809 tons, with engines of 5,000 indicated horse-power, and was followed in 1881 by the *Servia*, measuring 7,392 tons, with engines working up to 9,500 horse-power. Since then the Company have joined in the race with their competitors for pre-eminence on the Atlantic, as we have shown, and have, by the addition of the *Campania* and *Lucania* to their fleet, outstripped them all.

The *Campania*, the first of these vessels launched, is the largest vessel afloat, being 600 feet long between her perpendiculars, and 620 feet over all, and having 67 feet 3 inches extreme breadth of beam. Her depth from the upper deck is 43 feet, and she measures 12,950 tons. The next vessel in size to her in service is the *Teutonic*, which is 34 feet shorter, and 8 feet narrower. The *Campania* also exceeds the *Paris* and *New York* in length by 73 feet, but in breadth only 1 foot 9 inches. In fact, she is but 67 feet shorter and 17 feet narrower than the late *Great Eastern*, the largest ship built since the days of Noah.

The progress thus made is graphically illustrated in the woodcut on the preceding page of a group of typical steamers drawn in profile, from the *Sirius* downwards, and on a scale of relative dimensions similar to that of the other vessels already introduced into our text. The *Great Britain* is included because of her being the first ocean steamer with a screw propeller.

It is interesting also to compare the size of these last naval productions of the Cunard Company with their first steamer, the *Britannia*, built in 1840.* She was only 207 feet long, 34 feet broad, 22 feet 6 inches in depth, and measured only 1,154 tons. The *Campania* is therefore thrice as long, twice as broad, within three feet of being twice as deep, and nearly

* See woodcut on page 199.

twelve times her carrying capacity, and is fitted with engines twenty times greater in horse-power.

It will be readily understood that the greatest care and forethought must have been exercised on the structural arrangements of a vessel of such gigantic dimensions. And such we find to have been the case, for her builders, the Fairfield Company, have not only maintained the requisite continuity of strength throughout the entire length of her hull, in accordance with the principles of naval structure established by experience, but have also introduced many new ones demanded by the unusual size and proportions with which they had to deal. Advantage has been taken in the construction of the vessel of the improved sections of steel now available for the purpose in Channel and Z-bars, etc., in order to increase her strength without adding unnecessarily to her weight. The shell plating of her hull is in 26-feet lengths, and in some instances longer. From about the water-line to the keel the plates are fitted on the lap-butt principle, which has now generally taken the place of flush end-to-end butt-shaped joints in merchant ships. This change was originally brought about in order to save weight and riveting, but it is now used because it has been found by experience that the overlapped joint (lap-butt), though less sightly, is much stronger than the flush-butt. This method closely follows that adopted by Messrs. Harland & Wolff in the construction of the *Teutonic* and *Majestic*, and which has already been described. The Clyde builders have also followed very closely the plan adopted by the former in fitting the twin screws to the *Campania*, with the exception, however, that there is an aperture made in the stern frame, similar to that in a single screw steamer, in order that the propellers may work freely, although they are fitted close to the centre line of the ship.

The bottom of the vessel is constructed on the cellular principle for water ballast, the chief feature being minute watertight subdivisions. The upper, main, lower, and orlop decks are formed by plating over the beams on which they rest with steel sheathed with wood planks. The last mentioned is used for cargo, refrigerating chambers, store and other rooms. The other decks are entirely devoted to the accommodation of passengers, and fitted up on a scale of unsurpassed magnificence, with dining and parlour saloons, state and bathrooms, lavatories, etc. As in the White Star ships, no expense has been spared in order to render a voyage across the Atlantic as comfortable and enjoyable as is possible.

In the important matter of bulkhead subdivision, so far as it was practicable, all the suggestions made by the Parliamentary Committee* on Bulkheads were carried out. Excepting in the case of the engine-room, which is divided by a centre-line watertight bulkhead, a thwart-ship subdivision has been adopted throughout. A continuous centre-line bulkhead in the *Campania* would, it was believed by the builders, have seriously interfered with the arrangements of the boilers without giving a compensating advantage so far as safety is concerned. For example, the flooding of a large compartment on the port side after a collision would give the ship so dangerously a heavy list as to bring about a catastrophe like that which so unhappily befel H.M.S. *Victoria* under precisely similar conditions.

The eighteen compartments into which the *Lucania* and *Campania* are divided by thwart-ship bulkheads have been somewhat shortened, the maximum length of those amidships being only about ten per cent. of the total length of the ship, while at the ends, and more especially forward, where the risk from collision is greatest, the distance between bulkheads is considerably reduced. The subdivision of the vessel, in fact, is carried out to such an extent that any two, and in many cases even three, compartments might be flooded with water and the steamer remain in perfectly safe condition. The machinery, boilers, auxiliary appliances, etc., being in duplicate, the flooding of one or two compartments cannot well completely disable the propelling, lighting, or navigating, or any of the important machinery in the vessel. The construction of the bulkheads also follows on the suggestions of the Bulkhead Committee, for they are strengthened by deep bars of channel section instead of by angle irons. Openings, where necessary, have been made under the lower deck; but the number of these has been minimised, and they are in all cases fitted with watertight doors. In the more vulnerable parts of the ship, however, such openings have been dispensed with below the main deck. As the vessels are classed as armed cruisers for service when required by the British Admiralty, they have also been built to comply with the required conditions as to strength, buoyancy under disastrous conditions, and coal endurance. They have, amongst other provisions, therefore, watertight coal bunkers at the side of and over the top of the boiler compartments, forming a protection against the modern quick-firing gun.

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* See *Engineering*, vol. l., pp. 599 and 687.

The ventilation, both natural and artificial, is very perfect throughout the ship, even when the side-lights are closed in stormy weather.

The electric installation on board is in keeping with the other marvels of this gigantic vessel. It comprises four sets of generating plant, each set consisting of a Siemens dynamo, coupled direct to a Belliss engine, which, running at the rate of 280 revolutions a minute, gives a current capable of supplying 1,350 ten-candle power incandescent lights, including eight large reflectors of eight lights each for working cargo throughout the ship, and a powerful search-light which will be used in time of peace for facilitating navigation into port at night, and for scouting purposes in time of war. The extent of wire used throughout the ship in this installation is no less than forty miles in length.

The rudder of the *Campania* is of the ordinary centre-fin plate pattern, with arms on either side, strengthened by webs on the top and bottom in such a manner that when the ship is going full speed ahead it can be thrown hard over. The steering-gear is always a most important factor in the navigating appliances of a ship, but in one so immense as this new Cunarder great attention had to be paid to it. One general principle adopted by the builders is that of making the steering engine act directly on the rudder, instead of through the medium of chains which so frequently get out of order. Then the mechanism is so arranged that when the rudder is unduly strained it lets it go, and when the abnormal strain ceases it allows it to return to its former position.

The auxiliary arrangements in view of any derangement in the main steering-gear are in full harmony with the old spirit of forethought with respect to safety. In such a case it has been customary to depend upon a wheel worked by hand until the necessary repairs have been made. The size and speed of the *Campania* making this mode of steering not feasible, auxiliary steering-gear has been supplied by which the rudder can be as efficiently controlled as by the main gear. And then as another precaution against the breaking of the cast steel tiller worked by the latter, the auxiliary gear is so constructed that it can be applied to the rudder within a minute. To guard against even the failure of the latter arrangement, a pair of powerful hydraulic rams are provided with sufficient power to steer the ship.

In the event of the ship being used as a cruiser, and both the main and auxiliary gearing apparatuses being injured by an enemy's shot, they are supplied in addition with a steering station below the water-line connected by telegraph with the bridge.

The steering-gear which we have described is made nearly wholly of forged and cast steel and weighs 45 tons, and the rudder, as already stated, is 12 feet wide and 20 feet long. By the latter, aided by the twin screws working in opposite directions, these immense ships can be turned in a circle with a diameter of their own length.

The general arrangements of the engines of the *Campania* are similar to those first introduced by the Fairfield Company in the single screw steamer *Lahn* built by it in 1887. Each of them has five cylinders—two high-pressure, two low-pressure, and an intermediate cylinder. Although the adoption of the extra cylinder was evidently intended to reduce the size of the low-pressure cylinders, they yet have the enormous diameter of 8 feet 2 inches.

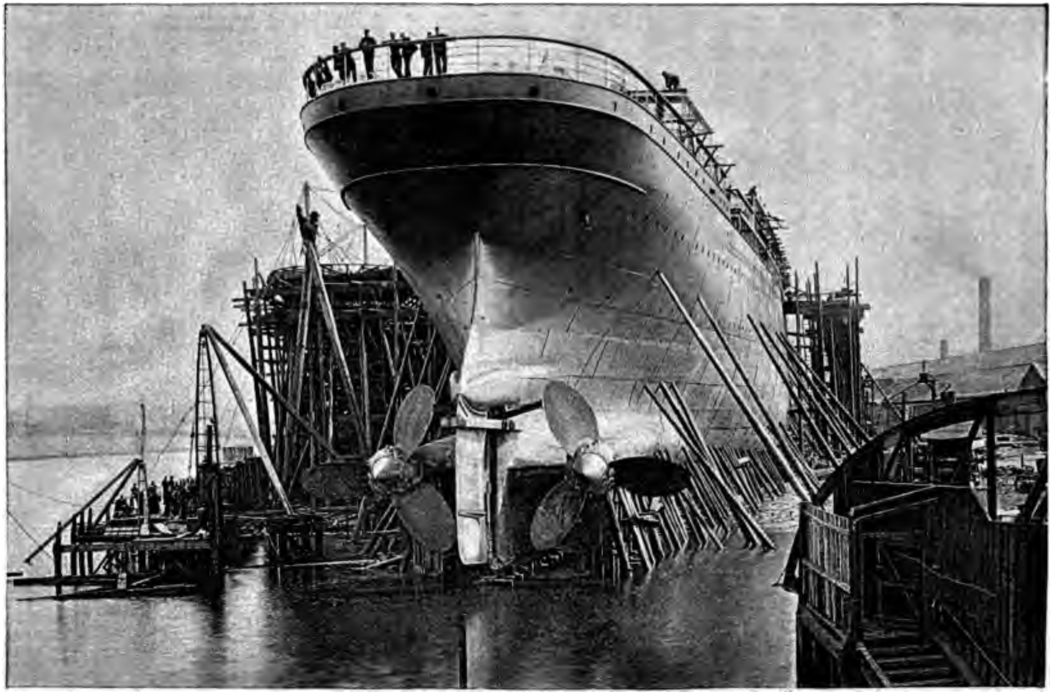
The cylinders are arranged tandem fashion—that is, with a high-pressure cylinder over a low-pressure one at each end, and the intermediate cylinder in the centre. The stroke of their piston is 5 feet 9 inches, and some notion may be formed of their size from the fact that their connecting-rods were made from steel ingots weighing 25 tons in the rough, but when finished 10 tons. The crank-shaft is 26 inches in diameter, or only one inch less than three-quarters of a yard. Each of three of its interchangeable parts weighs 27 tons, so that with the 14 ft. long thrust-shaft, each of the two crank-shafts of the *Campania* weighs about 110 tons.

The propeller shaft, fitted in twenty-four lengths, is 24 inches in diameter, each length having two bearings. The bossing out of the stern, as in the case of the *Teutonic* and *Majestic*, makes it possible to dispense with outside shafting, required under other conditions in the case of the *Paris* and *New York*, and to carry the shaft in the stern-tube as in the single screw steamer.

The boss of the propeller is of Vickers steel, and the three blades cast at Fairfield are of manganese bronze. Each blade weighs 8 tons, and, therefore, if pennies had been melted down to cast the six blades it would have taken 5,500,000 of them to do so!

The engines of the *Campania* and those of her sister ship are worked by twelve cylindrical boilers, 18 feet in diameter and 17 feet in length, and have four furnaces at each end, or ninety-six altogether. They are the largest boilers yet made to sustain a pressure of 165 pounds to the square inch. There are also two other boilers intended chiefly for the auxiliary engines, but which may also be used for propelling the ship, one of which is 18 feet in diameter and 11 feet long, and the other 10 feet by 10 feet respectively.

The twelve main boilers are placed longitudinally, three in a row in two groups, in separate watertight compartments divided from each other by a coal-bunker the full width of the ship, and 65 feet of its length. There are also other coal-bunkers over the boiler spaces, which curve to the sides in much the same manner as the protective decks do in naval cruisers. The coal is passed down to the stoking floor by shoots at the side, fed from the main coal-bunker between the boiler compartments. The total capacity of the bunkers is so large that the ship, if employed as a cruiser, will be able to keep at sea for long periods. The coal consumption in a voyage across the Atlantic has been estimated at 2,900 tons,



Stern of S.S. *Campania* before Launching, showing Twin Screws and Rudder.

which in a run of five and a half days would be at the rate of 527 tons or 10,540 hundredweight per day, or 440 hundredweight per hour! No steamer yet built has required such an amount of fuel to generate steam for her propulsion.

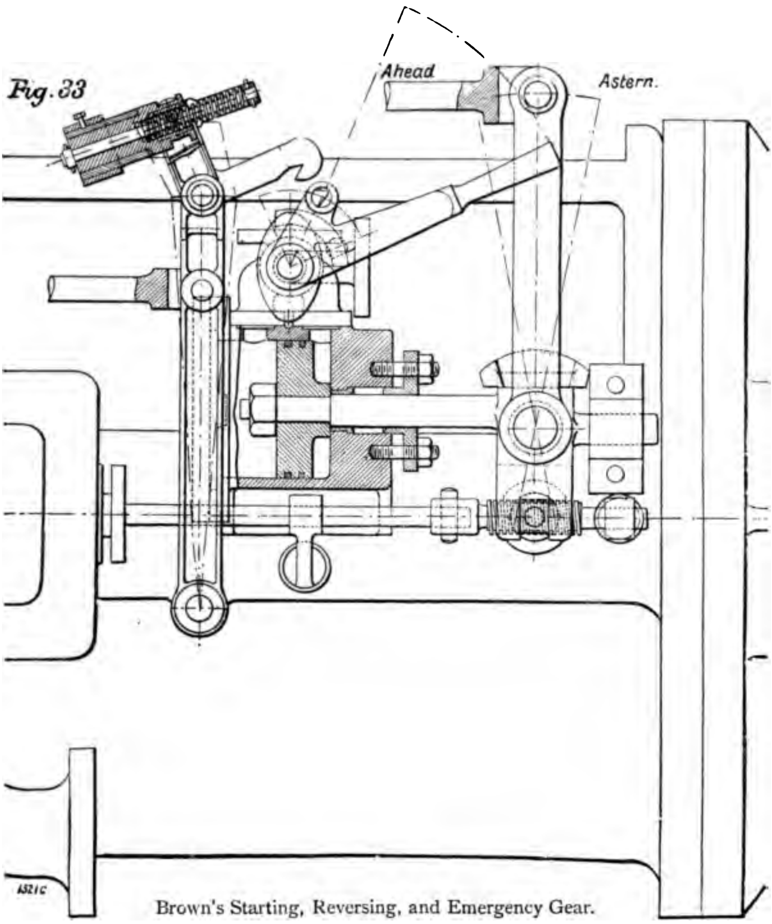
The gigantic proportions of the motive power of these vessels may further be inferred from the following facts. The machinery of each of their engines, from its base to the top of the cylinders, is 47 feet in height. The boilers which are required to keep it in motion, if placed end to end, would form a line measuring 204 feet, and if placed in rows of three each on top of one another would form a pile 72 feet in length and 54 feet in breadth. Their funnels are 25 feet outside diameter, and their tops rise 130 feet above the floor of the ship. If placed on the Eddystone Rock they would rise as high above it as does its lighthouse!

In order to start or reverse these gigantic engines the aid of steam had to be employed, by a cylinder in which a piston and rod by one stroke handles the links, as they are called, through which the machinery is put in motion. And here we meet with another recent improvement introduced under the exigencies created by the immense power of the new engines.

The attempts hitherto made to control their speed without interfering with the distribution of steam in each cylinder had not been found entirely satisfactory in working, owing to the complications it involved. In the case of the triple expansion engines it was therefore at first considered better to have them made of such a strength as would endure the strain of working up to even 100 per cent. above their normal speed, and then stop them or bring them to dead slow by the throttle-valve. The serious accident to the starboard engine of the *Paris* on a recent voyage called for something more effective than had as yet been used being added to the reversing engine, which, while being simple, would be more certain in its action. She was therefore fitted with a governor, which frequently stopped the engines automatically in very bad weather when the screw as usual began racing. In fact, it has been found so effective after severe tests for this purpose, that the engineers in charge are no longer required under such circumstances to "stand by" the handle of the reversing engine, but may leave it confidently to take care of itself. As the machinery by which this is secured is so ingenious in its arrangements and so wonderfully simple in its automatic movements, we venture to give our readers the following from *Engineering*, describing its application to the engines of the *Campania*. We are also permitted by the courtesy of that paper to use the woodcut given on the next page by which that description was illustrated.

"The reversing engine is of the oscillating type, the lower steam cylinder being attached to the column of the main engines, while the piston-rod is attached at its upper end to the weight shaft lever, which actuates the reversing links. The governor consists of a simple lever, which moves vertically with the main engines, and on which a weight is mounted supported by a spring so set that at normal speed little movement takes place. This is shown with the reversing mechanism on the hydraulic control cylinder in the woodcut. The usual reversing lever is here shown not working on a fixed fulcrum, but is attached to the end of a lever, its other end embracing and working the starting engine valve gear. The last-named lever works on a fixed fulcrum, while its other end is engaged with a steam piston and rod, working in a steam cylinder fitted with a three-way cock, so set that a constant pressure is exerted on the top of the piston when the marine engines are working at a safe speed. Just above this lever is arranged the governor lever already mentioned, which derives a reciprocating motion from the marine engines to the extent of 2 inches, and which can be conveniently connected by a rod to the indicator gear or

Fig. 33



Brown's Starting, Reversing, and Emergency Gear.

other reciprocating part. This governor lever carries at its other extremity a small weight supported on a spiral spring in a box. The weight is guided by a rod and collar, and has a groove at its lower part, into which one arm of a bell-crank lever gears, while the other arm is formed like a hook and is ready on emergency to engage and move upwards the valve lever of the steam cylinder.

"When the main engines are working at their normal or safe racing speeds in bad weather the spring is so set that the weight (which moves at each stroke of the engines in virtue of its momentum) shall not cause the hooked arm of the bell-crank lever to approach too near the valve lever. Should the main engines, from any cause whatever, exceed a safe limit, the weight, by an acceleration of speed, compresses the spring, causing the sharp hook at once to engage the valve lever. The result is that steam is admitted below the piston, exhausted from the top, lifting its end of the lever and depressing the fulcrum of the reversing lever, which, carrying with it the starting engine valve gear, turns steam on to the top of the piston of the starting engine, and so moves the links into, or somewhat past, mid-gear. By this device the motion of the main engines is arrested simultaneously in all the cylinders, which cannot be done by any closing of the stop valve, however quickly it may be effected. The controlling piston can be returned to its normal position when necessary to restart the engines."

CHAPTER XV.

The gigantic proportions of the hull and engines of the *Campania*, the records of her maiden voyages out and home, and her passenger accommodation.

THERE are many other things about these remarkable engines of the *Campania* that it would be interesting to notice, but which we are reluctantly obliged to pass over from want of space, such as the surface condenser, feeding and other pumps, etc. We therefore ask our readers now to come with us up from the stoke-hole and engine-room to the bridge, built of solid steel, and immediately before the forward funnel, and thus placed sufficiently aft to be clear of the heavy seas which break over the ship in heavy gales. In other steamers the *look-out* was from the forecastle deck, but on the *Campania*, as on several other of the large ships noticed, he is perched up in what is termed the crow's-nest on the foremast. Being thus elevated a hundred feet above water-level, the man on duty has a visual radius of fifteen miles under favourable atmospheric conditions. But even in a fog his position enables him to see the masts or funnels or smoke of vessels which would not be visible from the bows, for fogs generally extend but a few feet above the surface of the sea. Notwithstanding his great elevation, he is still within easy hailing distance from the bridge.

The great speed and immense length of these ships make it absolutely necessary that they should at every moment be under the direct control of the officer on the bridge. In order to secure this important object a double set of instruments has been provided for directing the whole staff during the watch from the bridge, and also a telegraphic communication between it and both engines. The quartermaster, therefore, from his little tower on it controls the heavy steam tiller gear by hydraulic power. By telegraph also the steering-house below the water-level can be communicated with from the bridge, should the former become deranged. There are also telegraphs to the windlass, deck machinery, warping capstans, so that the whole watch on decks and below when moving, is brought immediately under the direct orders of the officer in command. And when had ever a steamer engaged in peaceful commerce such a crew as each of the vessels has?—for it numbers no less than 415. This comprises 61 in the sailing department, which includes the commander, his 6 subordinate officers, and 40 A.B. seamen; the engineer department including its chief and 21 engineers, 18 greasers, 84 stokers, and 57 trimmers, in all 195; and the stewards' department, which includes a chief, 105 stewards, 45 cooks, bakers, etc., and 8 stewardesses.

But not only are we impressed by the gigantic proportions of the hulls and engines of these immense steamers, but also by the skill and enterprise and resources of the Fairfield Company, as shown in the remarkable shortness of time in which they were completed. The keel, for example, of the *Campania* was laid on the 22nd of September, 1891, and she was launched on 8th September, 1892. Her engines, which were made *pari passu* with the hull, were placed on board by the first week of the following December, and by the 26th of that month they were moved by their own steam!

We may also, with national pride, regard these noble ships as monuments of British skill and superiority in naval construction and engineering, as well as of commercial enterprise. It is meet that they should have come to us from the Clyde, where Symington, Bell, and others proved the feasibility of propelling vessels by steam, and where now, judging by these last products of the skill of their fellow-countrymen, it has been developed to the limits of human possibility.

And the ship-yard where they were built claims from us special mention in this connection, for it was at Fairfield that John Elder worked out the problem of adapting the compound principle of using steam to marine engines, as will be noticed more fully further on; and also where Dr. Kirk carried this principle a step further in 1874, by constructing a triple compound engine for the *Propontis.*

Mr. William Pearce, who entered the firm after Mr. Elder's death in 1869, and who became the sole proprietor of the business in 1878, so distinguished himself in naval construction that he received the honour of a baronetcy in recognition of his distinguished services. In conjunction with Mr. Robert Napier he designed and built vessels for the "Compagnie Française Transatlantique" which excited marked public attention, and in 1879 he entered heartily into the increasing competition in the Atlantic trade for fast steamers, and built the first of the so-called "greyhounds," the *Alaska,* for the Guion Line. Then when Messrs. J. & G. Thomson constructed the *Gallia* for the Cunard Company, he designed and built the *Arizona* to beat her. Still following up this successful competition, Fairfield produced in succession the *Oregon, Umbria, Lahn,* and the *Normannia,* exceeding by 6,000 indicated horse-power that of the *Teutonic,* and he has turned out in the *Campania* and *Lucania* the largest and most powerful steamers afloat, and with which their owners hope to win back the blue ribbon of the Atlantic. And this hope has been fully justified by maiden voyages of the *Campania* to and from New York since the above lines were written.

The *Campania* on her outward-bound voyage left Queenstown on Sunday, April 23rd. Her symmetrical proportions and her enormous steam power naturally excited the expectation that even on her maiden trip the vessel would surpass all former ocean performances. Great care and prudence were, however, required in working her gigantic engines for the first time, and in training her engineer staff in their management. Mr. C. Lane, the head of the Fairfield engineering department, and the superintendent engineer of the owners, therefore, went in her with instructions that the vessel should make the trip out under easy steam.

The Cunard ss. *Scythia* met the *Campania* in the evening of the day she left Queenstown, when she had so far averaged 20½ knots an hour. From this point, 70 miles west of the Fastnet, she encountered strong head seas and winds until Friday and Saturday, throughout both of which days fogs prevailed, occasionally very dense, so that speed had necessarily to be greatly reduced. No stoppage, however, was necessary on any account, the engines working smoothly, and she passed Sandy Hook Lightship at 5.24 p.m. on Saturday, thus making the passage in 6 days 8 hours and 34 minutes. This was at an average of about 19 knots per hour, or half a knot per hour better average than the best of maiden trips yet performed. Thursday appears to have afforded the only fitting opportunity for "letting her out," though not even then to her top speed, nor yet for the whole day; but between midnight and noon she ran at the rate of 22 knots per hour, equivalent on a whole day's run to 545 knots, or about 20 knots more than has ever yet been accomplished under similar circumstances.

The steadiness of the ship when encountering the heavy head-seas mentioned was stated by one of her passengers to be remarkable. Hitherto, according to the poet, the march of Britannia was "over the mountain waves," but in these days of heavy, massive, powerfully propelled ships like the *Campania*, it is through them.

The *Campania*, on her return voyage, crossed the Sandy Hook bar 15 minutes after the *Paris* of the American Line, also bound east, had done so, and although delayed by a stoppage of half an hour to tighten some nuts, passed her six hours later in a run of 109 miles from Sandy Hook.

The *Campania's* daily runnings were as follows: 486, 490, 474, 517, 493, 439 knots to Queenstown, or a total distance of 2,899 knots, or 3,332·499 statute miles—run in 5 days 17 hours 27 minutes. This gives an average of 21·15 knots or nearly 24·470 miles per hour; but in one day the rate was 22·24 knots or 25·621 miles per hour. The daily average was 507·6 statute miles.

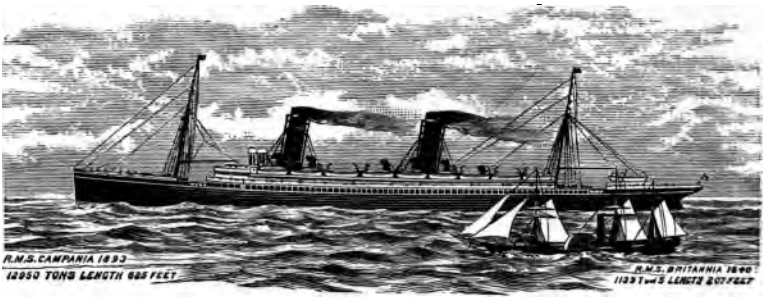
On referring to the previous records made by Transatlantic steamers, it will be seen that the highest day's running to the eastward of any ship hitherto was the *Teutonic*, which made 483 knots in one day, the next best being the *City of New York*, which made 475. It will be observed that the *Campania* exceeded the best of these day's runnings on almost each day of her homeward passage, and on one of them by as much as 34 knots.

The American Line steamer *Paris*, which has hitherto held the record for the best Western passage, left New York a few minutes before the *Campania*, but did not pass the Lizard (160 miles from Southampton) until five hours and three-quarters after the *Campania* was at anchor in the Mersey. The *Campania's* run from New York to the Mersey (Rock

Light) was performed in 6 days 4 hours 29 minutes, including stoppage at Queenstown.

The transition from New York on Saturday to Liverpool on Friday, is an accomplishment of which the owners and builders of the *Campania* may justly feel proud.

It is not until a vessel of her class has made three or four voyages that her full measure of speed is attained. The *Campania* may therefore be expected soon to materially shorten the record she thus made on her first return voyage. When her sister ship, the *Lucania*, is placed on the service,



The first and last Cunarders.

we shall probably find it possible to leave Liverpool on a Saturday for New York and be back on the following Friday week—a feat which is little less than astounding, when all the attendant circumstances are taken into consideration.

At the last annual meeting of the Cunard Company at Liverpool, Sir John Burns, its chairman, in moving the adoption of the report, said that he "congratulated the Company upon soon becoming possessors of two of the finest steamships which the world had ever seen, or was likely to see for some time to come. They had heard much of foreign competition in steam navigation, in which the United States had now joined, but he believed with such ships as the *Campania* and *Lucania* England would be able to hold her own against them all."

These magnificent vessels are not only worthy of the traditions of the Cunard Company, but are also in every respect most creditable to the skill of their designers and builders. Yet regarding them from our general standpoint of observation they must be looked upon both in their models, hulls, and internal arrangements as the last achievement in the era of naval construction introduced by the White Star Line and their Belfast shipbuilders.

Sir Edward Harland, in a letter to *The Times* after the *Campania* was launched, claims this honour in the following terms:

"The larger hull of the *Campania* is in more modern proportion and lines, and propelled by more economical machinery than is the *Umbria*, and will no doubt be a great pull for the owners while giving greater speed and comfort to the travelling public. The owners and builders of the White Star Line may well feel flattered by the spirit of imitation evinced in this crowning effort of the Cunard Company, which is a *facsimile* of the *Majestic* and *Teutonic*, not only in the model and arrangements of her superstructure, but also in the mode of construction, especially in the shell-plating and the method of supporting of the twin screw shafts in the 'run' without the aid of the usual brackets, as well as in the facility with which her present propellers, if found too small, may be increased in diameter by overlapping them in the manner found so advantageous on the *Majestic* and *Teutonic*, as being not only snugger when docking but less apt to race in a heavy sea."

The grand stairway is in keeping with the proportion of all

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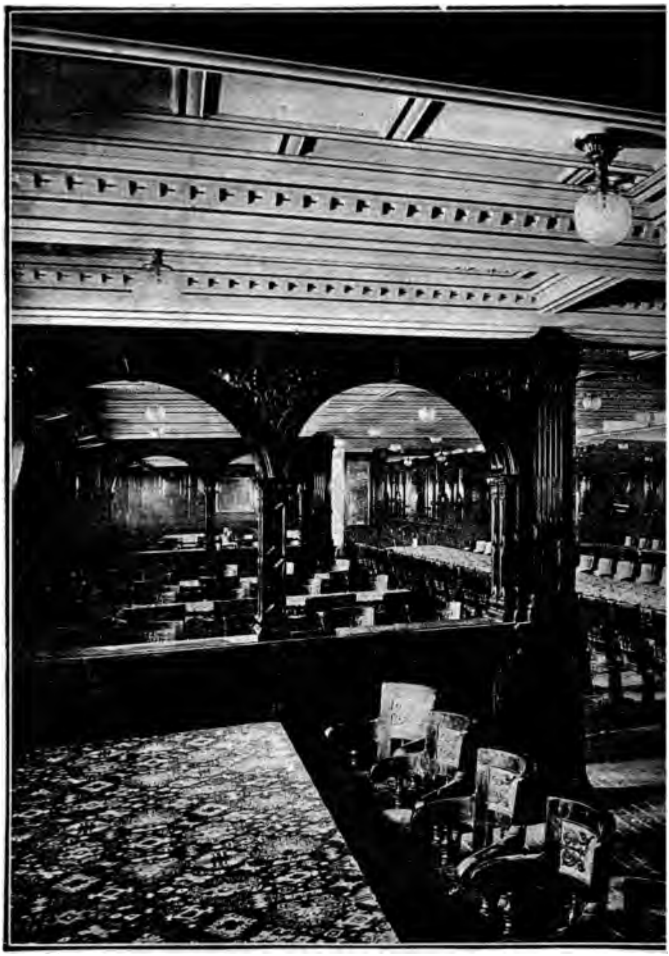

DINING SALOO

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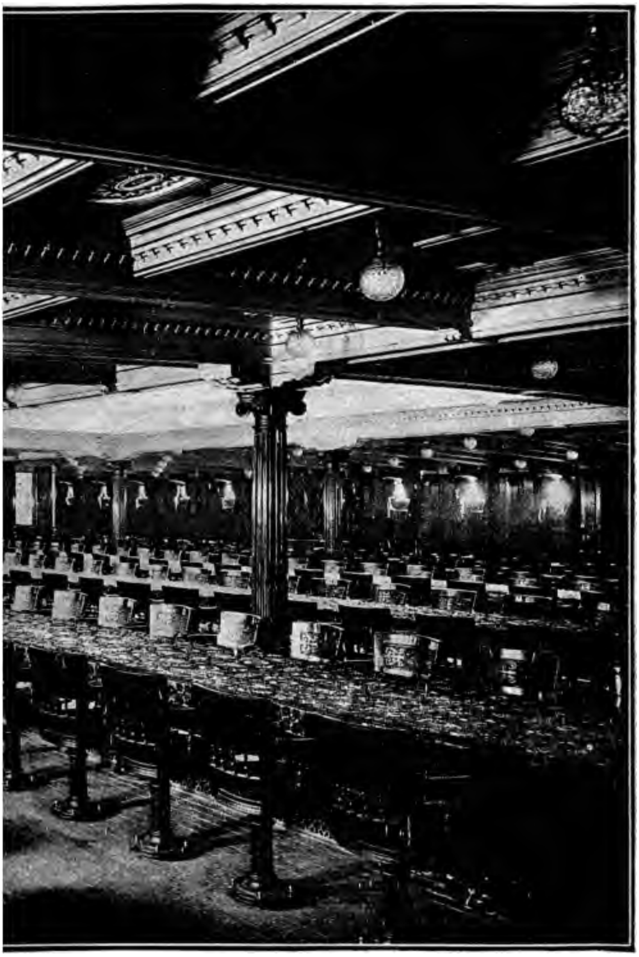

MPANIA.

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the other appointments for the comfort of cabin passengers on this large steamer. Its main entrance is from the promenade deck, where it has necessarily a communication with the upper deck. The latter is narrower than the stairway leading down to the saloon on the main deck, which is broad enough for from two to three passengers to pass each other abreast in ascending or descending. The roof is curved, with a large skylight in it which gives ample light. Besides the usual side rails this broad part is provided with a central hand-rail to afford support when the ship suddenly lurches.

The dining saloon is 100 feet long, 62 feet broad, and 10 feet in height throughout. Its general style is Italian, somewhat sobered down by an air of British substantiality. The decorations throughout, although highly artistic, are neither gaudy nor oppressively elaborate, as will be noticed in our woodcut. Its walls are of chastely designed Spanish mahogany, and the upholstering is in a dark rich red figured frieze velvet with curtains to match. It also lacks stiff uniformity owing to the various air and ventilating shafts, stairways to lower cabins, and partial bulkheads breaking up its area. The latter have, by judicious planning, been taken advantage of to form nooks and corners where small parties may dine in complete seclusion. There are four large public dining-tables running fore and aft the saloon, provided with the usual revolving chairs with the company crest—a lion rampant—carved on their backs.

The forty side-lights of the saloon—twenty on each side of it—are of unusual size, and are fitted, like the *Teutonic* and the other ships described, with Utley's patent ventilator. An inlet for fresh air even in the roughest weather is thus secured. The outlet is provided for by oval ventilating shafts through the roof of the saloon, and thence by passages and shafts to the awning deck, where, from their elevated position, they may always be left open.

For lighting, as well as for ventilating, there is a central well 24 feet long and 16 feet broad, carried up from the saloon through the upper and promenade decks to just above the awning deck, where it is covered by a curved dome of stained glass, with an outer covering of thick glass in teak framing. The latter is hinged to open for ventilating purposes.

We pass now from this grand *salle-à-manger* to the drawing-room, opening out on the promenade deck, and which is 60 feet long by 30 feet broad, and lighted through large oblong windows and from the well which passes up through it. The "ingle neuk" at the forward end of the room, of which we give a woodcut, gives the room a cosy and home-like appearance. Its mantel and over mantel are in richly carved satinwood with three arched mirrors. The grate is of brass, and its hearth and cheeks are laid with Persian tiles. The walls of the drawing-room are also in satinwood, relieved, however, with cedar mouldings. The frieze panels are of plane-tree, and the ceiling is in pine, decorated in light tones in which old ivory with a slight gilding prevail. The settees, ottomans, and chairs are upholstered in rich velvets and brocades of various colours. The charming variety of its furniture, and the rich Persian carpet on which it rests, give the room a superbly attractive appearance. A Collard grand piano and an American organ complete and add to its other attractions.

The library, also on the promenade deck, is 29 feet long by 24 feet wide. The style of architecture suggests that of the Renaissance. The roof is very ornate, and painted in two shades of ivory, with electric lamps in the form of rosettes of beaten copper forming the central design in each of its alternate panels. The columns supporting it, and which form

DRAWING-R

(LOC

MPANIA.

[*To face page* 202.

the central part of the two ottomans in its centre, are covered with Mecca and blue velvet. The chairs and the ottomans themselves are upholstered in a lighter material, and the curtains are of a rich brocade. The walls of the room are finished in richly-carved mahogany with Amboyna panels. Writing-tables and chairs are arranged close to the sides of it, and its highly ornate book-case is filled with a varied selection of works.

The smoking-room is 24 feet long by 24 feet wide. Its decorations are in the old Scottish baronial style, with chairs and tables to match. At one end is its special bar, and in recesses round it are small tables with seats, where a quiet game of dominoes, backgammon, or whist may be enjoyed, and where, alas, also, "contrary to rules," of course, the professional gambler may as quietly empty the purse of some green fellow voyager.

The height of the majority of the state-rooms is, like that of the saloon, their distinctive feature, for it approximates 10 feet. Although this secures satisfactory ventilation for their inmates, jalousies are adopted wherever practicable, as well as Utley's system of ventilation, so that even in the case of inner rooms the air is consequently constantly changed. In the *Campania*, as in the other recent new passenger steamers, the old wooden berth has been superseded throughout the ship. Those in the state-rooms are of Hoskins' "triptic" type, and so constructed that the upper bed folds up against the bulkhead. The lee-board in the old style extended the whole length of the berth, but in the modern plan it extends only half its length. As it can be fixed at either end or in the centre, the passenger has therefore freedom of movement either out or into the berth. There are rooms suited to all tastes—single and double-berth cabins and family rooms.

The latter are actually *en suite*, fitted in beautiful satinwood and mahogany, with everything to match. Only think of a parlour and bedroom all to yourself in crossing the Atlantic, the latter furnished with a brass bedstead with overhangings, and the former fitted up with tables and chairs after the style of a lady's boudoir! There is another class of state-rooms panelled in hard wood instead of being painted, and fitted with a collapsible bedstead, or a piece of ingenious machinery capable of being extended so as to form a double bed, and which, when used as a single one, may be converted into a couch and settee.

Although it would be interesting, if space permitted, to describe in detail the electrical arrangements, lavatories, and heating of this part of the ship, all of which are as nearly perfect as they apparently can be made, the second class and steerage accommodation must now, however, claim our attention.

The public rooms for the former are all placed abaft the machinery, and the dining saloon on the upper deck is furnished in a style equal to that of the first-class saloon in ordinary ships. It has also its drawing-room on the promenade deck, with a cottage piano finished in satinwood to suit the general decorative style of the room.

The smoking-room is in the poop, and is finished in American walnut, and has, as in the case of the first-class saloon, a bar attached to it. Almost the only difference between the fittings of the first and second class cabins and state-rooms is in the use of brass mountings instead of those of electro-plate in the former, and the large number of four-berth state-rooms.

The steerage is on the lower deck, and is fitted with iron portable berths. Its passengers are allowed to promenade on the upper deck, which has such a circuit that five times round it is equal to a walk of one mile.

Here let us go back to the first steamer of the Cunard Line, and compare her passenger accommodation with that of this last one added to its fleet. The *Britannic* could only carry 115 cabin passengers, and the fare was thirty guineas, and for a separate room fifty. The *Campania* has accommodation for 600 first-class, 400 second-class, and from 700 to 1,000 third-class passengers. First-class accommodation can be secured in her for from £12 to £15, and the emigrant fare is as low as £4 to £4 10*s.*, or about what it used to be in sailing ships without food or any of the comforts now provided for this class of passengers. The demand, however, for luxurious quarters has been supplied by a special class, for which high rates are paid. Some of our first-class passenger ships receive more in fares in one voyage than did the first fleet of the Cunard Line receive in a whole year. The *Teutonic*, for example, in seven voyages in 1890 had an average of 1,400 passengers each trip, while the *Majestic* in nine trips had an average of 1,357. The gross receipts of the *Paris* from 550 first class, 200 second, and 450 steerage was £13,500! So, as our readers will easily infer, the building of such large vessels as the *Campania* and *Lucania*, although their cost is about £600,000, is likely to yield a large profit to their owners from this department of revenue alone.

But there is another aspect in which this improved passenger accommodation and reduced fares for Transatlantic voyages, as well as for other longer ones, may be viewed. Before locomotion on land by steam was established, a journey by coach or on horseback was such a serious matter that but few comparatively attempted it. The number of passengers annually travelling by rail in the United Kingdom has so increased that it now runs up into the millions. This is the result of the cheapness and rapidity of intercommunication between even the most distant points, and improvements in the accommodation for travellers. And the same causes have produced the same effects with respect to travelling by sea. Taking as our starting-point the year 1840, when the Cunard Company was first established, and a few subsequent quinquennial periods, we find, for example, an enormous annual increase in the number of alien passengers arriving in the United States from foreign countries.

In 1840 the number of such passengers was but 84,060; in 1845, 114,371; and in 1850, 310,004. In 1854 the numbers were 427,833, but only 200,877 in 1855. In 1870 the number was 379,854, in 1880 it was 622,252, and in 1881 and 1883 respectively there were 743,789 and 764,303 arrivals of aliens at American ports.

It is understood and admitted that the increase of the population of the United States had, of course, an important influence on this increase of the passenger traffic, but it must also be remembered that both these attractions and influences were largely indebted to the establishment of our ocean railways across the Atlantic.

Sir John Burns complained at the meeting referred to, in the course of his remarks, that the subvention paid to the Cunard Company subsidising the *Etruria* and *Umbria* as armed cruisers was about to be withdrawn, and that this would discourage shipowners from building ships suitable for purposes of war. He was not aware at the time that this subvention was merely withdrawn from these vessels to be transferred to the *Campania* and *Lucania*, and to be increased from £12,000 annually to £19,000. There can be no doubt about the grounds upon which this was done. The *Teutonic* and *Majestic* were built on designs approved by the Admiralty as calculated to meet in every respect the requirements of their service as armed mercantile cruisers in time of war. According to Sir Edward Harland's statement, these designs have been closely followed in the construction of the two new Cunarders, and therefore they are subsidised by the Government in preference to the *Etruria* and *Umbria*, judged by it not to be so well suited for such a service.

We cannot, however, altogether agree with Sir John Burns in the opinion he expressed on the above occasion that, for many years to come, no such ships as the *Campania* and *Lucania* will be constructed. Reasoning from the past, there are grounds, as will be shown in our next chapter, for anticipating a still further advance in mercantile naval construction, and in the development of propelling power on ocean-going steam vessels.

CHAPTER XVI.

How steam at its present high pressure was rendered available through surface condensation, triple expansion, and improved boilers and furnaces.

As steam will, without doubt, continue to be the motive power, improvements not only in its generation and economy in its use, but also in the mode of its application may be anticipated. Had it not been for the advance already made in these respects, such large vessels as those recently added to our mercantile marine could not have been brought into existence, nor could our ocean railways have been extended over such long distances as they now are. Brunel's idea of large ocean vessels failed at the time because of the lack of propelling power, which since then has been supplied by improvements in the steam-engine.

These improvements were largely consequent upon the demand for greater economy in fuel in connection with long ocean voyages. This was met in three ways: first, by the introduction of the surface condenser, then by the invention of compound engines, and thirdly, by the improvements introduced into the latter, which resulted in giving us the so-called "triple expansion engine."

In surface condensation, for example, the steam is brought into contact with the exterior surface of a great number of small tubes, through which a current of cold water is made constantly to flow by pumping. This mode of dealing with the exhaust steam keeps it and the water used in condensing separate. The water drawn from the sea for this purpose is returned to it again, while that into which the steam has been converted in the process is sent to the "hot well" and pumped back again into the boilers, to be reconverted into steam again. This fills the boilers with distilled water, and obviates the wasteful process of "blowing off" to get rid of the unvaporisable salt matter which sea-water holds in solution, and which otherwise would be deposited in the boilers and clog them. Under the old system the sea-water used for condensing the steam was brought directly into contact with it, and then it and the distilled water from the latter was pumped into the boilers, with the unfavourable results to them which the new system prevents.

In compound engines two cylinders of unequal size are used, the larger of which is called the low-pressure, and the smaller one the high-pressure cylinder, the former having three times the capacity of the latter. The steam is admitted from the boiler into the high-pressure cylinder in the usual way, and generally cut off from it at either two-eighths or five-eighths of the stroke. After doing its work therein, it is conducted into the large cylinder, where, in its reduced pressure, it does as much work as it did in the other cylinder, on account of its acting on an increased area, and then passes in the usual course to the condenser.

The advantages of this system of engine are obvious, and are as follows: First, the ordinary pressures of the steam are more uniform than in ordinary engines. Second, the leakage past the piston becomes of very much less importance. Third, for any given large measure of expansion the mechanism of the engine is much more simple than is required for the same degree of expansion carried out independently in two cylinders. Fourth, the losses due to the condensation of steam in the cylinders—the most serious of all the causes of its waste—are very much reduced.

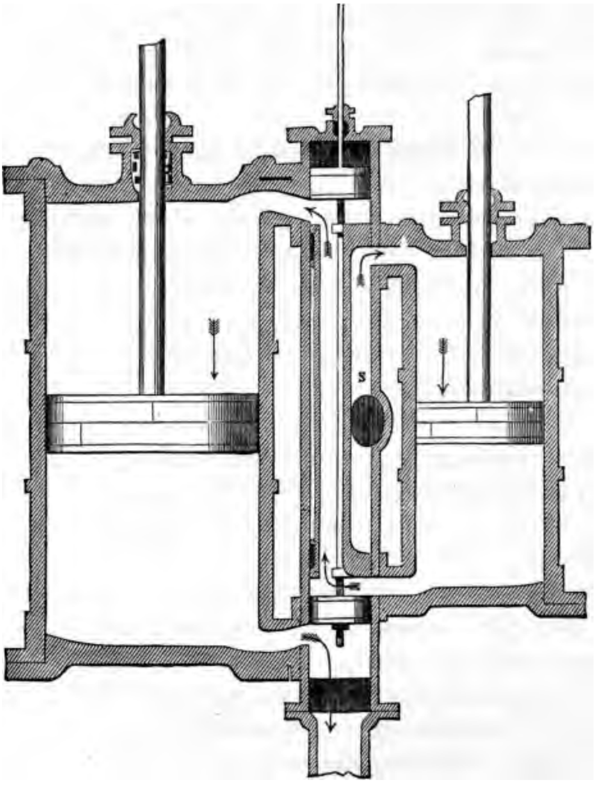
The third great improvement mentioned of the steam-engine is but carrying further the principle of the compound engine. Triple expansion engines are simply the former with three cylinders in which the steam is used consecutively, instead of two cylinders.

In triple expansion engines steam is not uncommonly used under a pressure, as we have seen, of 150 pounds to the square inch, or about six times the pressure as was usual in 1860. Mr. Holmes, in his "Marine Engines and Boilers," in referring to the saving of fuel by the introduction of triple expansion engines, states that:

"Several direct comparisons have been made between the fuel consumption of ordinary, compound, and triple expansion engines of the same power when fitted to boats of similar dimensions and lines. In one instance the comparison was between two passenger steamers of over 4,000 tons gross measurement, having engines of 6,000 indicated horse-power, one of the ordinary compound type working with steam at 90 pounds, while those of the other were triple expansion, with steam of 145 pounds per square inch. The saving in fuel in the latter case amounted to 14·28 tons per diem, or 1,200 tons on the round voyage of 84 days, which corresponds with a diminished consumption of coal of about a quarter of a pound of coal per indicated horse-power per hour."

Another case mentioned by this author was that of a vessel fitted with compound engines, working with steam of 60 pounds. New triple expansion engines and boilers, working up to 150 pounds per square inch, were fitted to her, when the consumption of coal on the same speed was reduced 25 per cent.

The idea of the compound engine dates from the time of Watt, for in 1781, Hornblower, a Cornish engineer, took out a patent for a single-acting engine with two cylinders, the steam being allowed to expand in the second after acting in the first.



Woolf's Compound Engine.

The first double-acting compound engine was patented by Woolf, in 1804. He used two cylinders of different sizes, placed side by side, as shown in our woodcut. The smaller cylinder received the steam from the boiler through the pipe S, which then acted in it at full pressure throughout the whole length of the stroke. Next it was admitted to the opposite side of the piston in the large cylinder and allowed to expand simultaneously in both cylinders. At the end of the stroke the whole of the steam was in the large cylinder and opened into the exhaust. The high-pressure steam was therefore exposed to the whole difference in temperature due to the complete range of expansion, and much of the advantage appertaining to the system of compounding was thus lost. The high-pressure cylinder was not, however, exposed to the temperature of the condenser, which it would have been had the whole expansion taken place in a single cylinder.

Although Woolf realised an enormous economy in the use of steam in his engine as compared with that of Watt, it was chiefly due to the fact of his having made use of Trevithick's invention of high-pressure steam. The results obtained by this Cornish engineer when he began using it in a single cylinder were equal to those obtained by the former in his engine of two cylinders.

Trevithick took out a patent in 1802 for a high-pressure steam-engine planned to work without either condenser, cistern, air, or cold water pumps. These important omissions were made in order to apply steam-power to locomotion on land, and which he successfully accomplished that year. Ever since then locomotive engineers have led the way in the matter of high pressures, and have only been overtaken in the end by the builders of marine engines.

The difficulties which delayed the latter in their efforts to increase the power of their engines on a given weight were many. They were met in the earlier days of steam navigation with the difficulty of constructing a boiler that could safely be used when worked at pressures even of a few pounds in excess of that of the atmosphere. There was also the impossibility of working a boiler fed with salt water up to a greater pressure than from 35 to 40 pounds to the square inch, on account of the deposit of the solid, unvaporisable contents of the water in large masses all over its heating surfaces.

It was not until the successful introduction of surface condensation, through which boilers could be fed with fresh water, that this difficulty could be removed. For many years 60 pounds to the square inch was looked upon as a very high working pressure. With improvements in the manufacture of boilers steam of 90 pounds came into vogue, and now, thanks to the use of mild steel as the material used in their construction, as well as corrugated cylindrical furnaces and the adoption of powerful hydraulic machinery for closing up and riveting the seams of shell-plates, it has been possible to work up to a pressure of 160 pounds. Until such improvements were initiated, Woolf's principle of compounding engines fell into desuetude, and primarily, as stated, through Trevithick's successful use of high-pressure steam. Still, various attempts were made to introduce that type of engine in vessels. It was not, however, until 1856 that this was practically accomplished under the following circumstances.

The first shipping company to adopt the compound engine was the Pacific Navigation Company, which had two paddle-wheel steamers (the *Valparaiso* and the *Inca*) built that year by Messrs. Randolph, Elder, & Co., fitted with them. They had four cylinders—two high-pressure of 50 inches, and two low-pressure, 90 inches in diameter—steam-jacketed top and bottom only. The pressure of steam used was 25 pounds above the atmosphere. The condenser was of the old jet description.

The distribution of the steam was precisely similar to that of Woolf's engines, and consequently the full effect of the compound engine in checking condensation was not realised. The engines of these two steamers only developed something less than 90 horse-power, the speed of their pistons being from 230 to 250 feet per minute.

The economical results, however, of these engines were so satisfactory that the other steamers of the line were subsequently fitted with them, but were improved by the cylinders being jacketed all over in accordance with the precept laid down by Watt, of always keeping the cylinders warm. As the result of this improvement the indicated horse-power of the new engines rose from 900 to 1,150 horse-power.

Remarkable progress was further made in engines supplied to steamers of the Pacific Company, for surface condensers were used in them, and they were worked with steam rather over 40 pounds pressure, and developed 1,450 indicated horse-power.

In the *Arequipa*, which commenced running in 1870, steam of 60 pounds pressure was used in cylinders only 38 and 78 inches in diameter respectively, while the power developed by her engines was raised to 1,720 horse-power. It will thus be seen to have been found possible by using surface condensation to nearly double the power, and at the same time to reduce the size of the engine. The coal consumption was enormously diminished, as the quantity burnt per indicated horse-power by the *Arequipa* was only half of what it was in the original engines of the type in the *Valparaiso*.

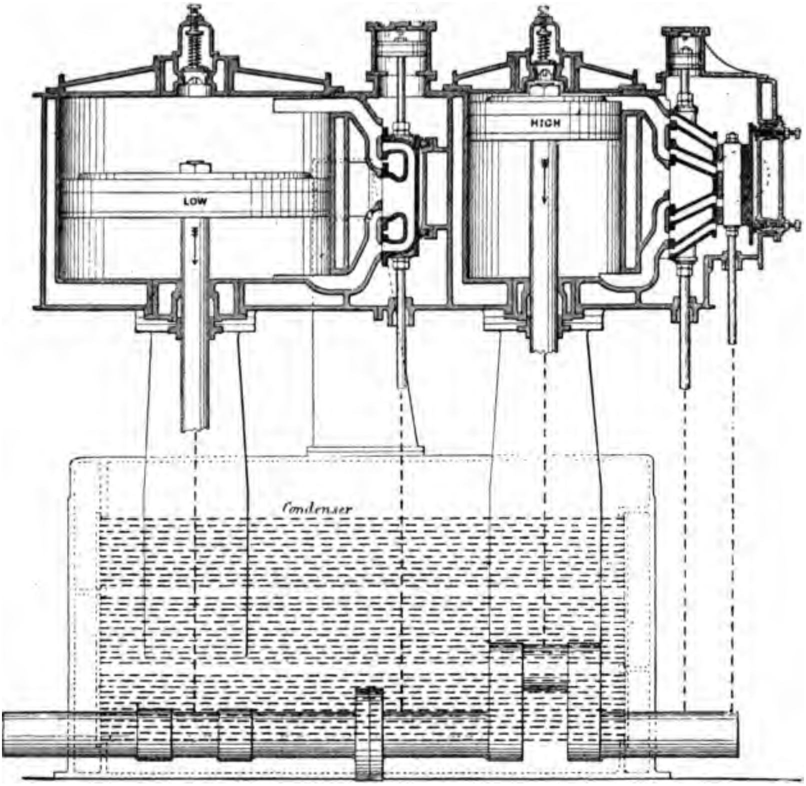
The improvements thus introduced by Messrs. Randolph, Elder, & Co. into the later engines with which they supplied the vessels of the Pacific Steam Navigation Company originated with Messrs. Rowan & Horton, who in 1858, or two years after the *Valparaiso* was engined by the former firm, fitted the *Thetis* with compound engines. These boilers were remarkable at the time for carrying the very high pressure of 115 pounds to the square inch. Surface condensers were also for the first time used in them.

The engines of the *Thetis* were a great success, her coal consumption on her trial trip being only 1·018 pounds per indicated horse-power, and at sea about 1·86 pounds per indicated horse-power. This result must, however, be largely ascribed to Mr. Rowan's boilers, which were found capable of evaporating 11 pounds of water per pound of coal burned in them.

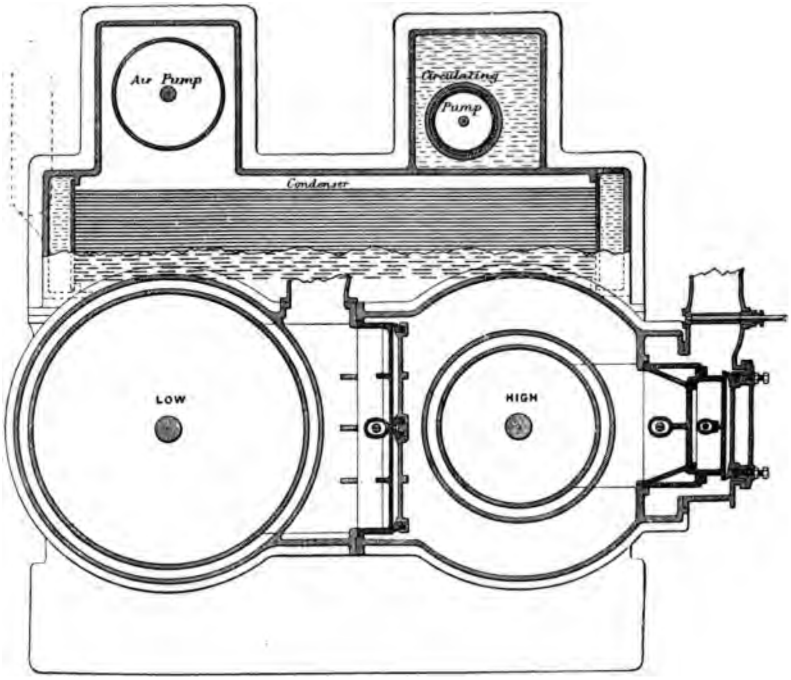
The Woolf type of compound engine possessed amongst other serious disadvantages, that of its pistons necessarily occupying simultaneously the same or opposite positions in its two cylinders. It is evident, therefore, that when only two cylinders are used there must be only one crank or else two cranks exactly opposite to each other, and in neither case could either piston derive any advantage from the other in getting over the dead centres. In order to remedy this defect, Messrs. Randolph, Elder, & Co. used four cylinders in the engines supplied to the vessels of the Pacific Steam Navigation Company.

The practical need of the mercantile marine was for a two-cylinder engine working cranks at right angles to each other. To meet this demand the "receiver" type of compound engine was introduced, in which the steam, after doing its work in the high-pressure cylinder, was allowed to enter a receiver in which it was retained until the low-pressure cylinder was ready to admit it, for, as the cranks are at right angles, the piston of the large cylinder is only about mid-stroke, and therefore not ready to receive the steam from the smaller one.

Nor is the steam in this type of engines allowed to pass uninterruptedly from the boiler into the small cylinder throughout the entire stroke, as was the case in the Woolf engine, but is cut off and allowed to do the rest of its work by expansion in it. It is also cut off before the end of the stroke in the large cylinder, and likewise allowed to expand. The advantages thus secured were an economy of steam, and a more favourable arrangement of the ratio of initial to mean pressures.

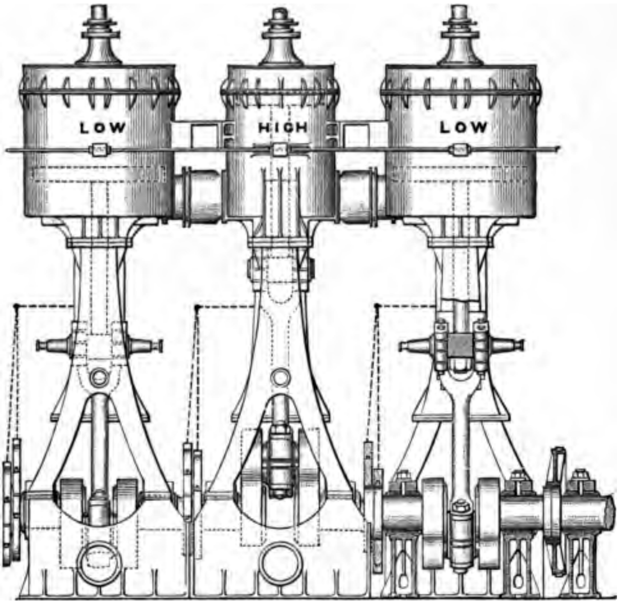


In order that our readers may fully apprehend these interesting stages of progress in the economy of steam, which by still further improvements have given us our present perfected and powerful steam-engines, we give the accompanying two woodcuts illustrating one of the earlier invented two-cylinder compound screw engines.



That on the opposite page represents a longitudinal section through the two cylinders, and also shows the valves and steam passages. The receiver is the whole space between the back of the high-pressure valve and the admission part of the low-pressure cylinder. It is so disposed as to surround the small cylinder shown in the sectional plan of the above woodcut.

As in engines of great power the low-pressure cylinder would become inconveniently large in its diameter, two low-pressure cylinders of equal size are used instead, which with that of the high-pressure gives three in all, working on to as many cranks, usually making equal angles with each other.



Scale 3/400

Tandem Engine.

The high-pressure or small cylinder in such a case is placed between the two larger, or low-pressure cylinders.

Amongst the many forms of compound engines in use besides those described, the most common is that known as the "tandem engine," so called on account of its high and low-pressure cylinders being placed in line, as shown in the above woodcut.

This form of engine is not only very simple, but provides perfectly for the expansion of steam. Its advantage for marine purposes is that being a perfect unit in itself, it can be repeated according to the number of cranks. When two of the latter, for example, are used, all that is necessary is to place a second tandem engine over the second crank, and so forth. Several of the White Star and Inman steamers carry engines of this type. The *City of Rome* was fitted with three sets of such engines driving three cranks, the united power of which indicated 8,000 horse-power.

When the type of compound engines became common between 1870-1872, with boiler pressures of an average slightly under 60 pounds, the coal consumption at sea was reduced 50 per cent. of what it had been under the old type of engine. During the next decade pressures increased, so that in 1881 those of 90 pounds to the square inch were quite common, and the consumption had been reduced from the average of 2·11 pounds of coal per horse-power per hour to 1·828 pounds per hour. The piston speed also had increased during the latter period from 356 feet up to 460 feet per second, with a marked increase of the power obtained from a given cylinder.

As we have already stated the economy which had thus been realised by compounding engines, marine engineers went on advancing on the same lines, in order to effect further savings and increased power, until our present triple expansion type of engine was produced. Their initial difficulty was with the boiler, for in those days iron was nearly the universal material used in the construction of those used for marine purposes. There was a reluctance to employ iron plates of the thickness required by the regulations of the Board of Trade, and of Lloyd's, for such high pressures. There was also a suspicion that the cylindrical furnaces, usual in marine boilers, would be very liable to collapse under the new conditions. An attempt was made, however, to get over these difficulties by the use of water-tube boilers, or boilers in which the water was contained within a number of iron tubes of comparatively small diameter, and therefore of high strength, on the outside of which the fire acted.

The honour of devising machinery best suited for the utilisation of steam of such high pressure to advantage belongs to Mr. A. C. Kirk, now senior partner of Messrs. R. Napier, of Glasgow. He foresaw that in order to realise the desired economy, the difference of temperature of steam must be spread over three instead of two cylinders of progressively increasing capacities, each of them working a separate crank. Mr. Kirk therefore fitted the *Propontis*, built for Mr. W. H. Dixon, of Liverpool, in 1874, with an engine having cylinders of 23, 41¼, and 62⅛ inches in diameter respectively, with a stroke of 42 inches.

The owner, fully impressed with the advantages to be gained by the use of steam of higher pressure than that usually employed, had her fitted with boilers according to the tubular system described, which could bear a pressure of 150 pounds per square inch. The engines designed by Mr. Kirk gave perfect satisfaction, but the chambers over the fires in two of them were burnt and eventually burst.

After the failure of the water-tube boilers of the *Propontis* no shipowner was found willing to run the risk of adopting steam of such high pressure until 1877–8, when such improvements had been made in the manufacture of mild steel as to permit its application to the construction of marine boilers. The superior strength of the metal made it possible to reduce the thickness of the plates 25 per cent. for a given pressure, or to increase the pressure 30 per cent. for a given thickness of plate. About this period Mr. Fox, of the Leeds Forge, brought out corrugated furnaces of such comparative strength with the old plain, cylindrical furnace, that the danger of these parts of boilers collapsing was done away with.

Simultaneously with these improvements were great advances made in the appliances and tools for riveting boilers, so that the cost of construction by hand labour was so reduced that greater thickness of plate could be economically dealt with. As the consequence of the three above-mentioned improvements there has since been found no difficulty in the construction of boilers of any required dimension which can with absolute safety bear pressure of 150 to 170 pounds to the square inch, as we have seen to be the case in the last addition made by the Cunard Company to their fleet. What a contrast she presents in her power and speed with those of its pioneer ship, the *Britannia*, with her coal consumption of only 44 tons of coal a day, her boiler pressure of but 9 pounds to the square inch, and her speed of a fraction only over 8 knots an hour!

CHAPTER XVII.

Advantages consequent on the present use of steam, including not only acceleration of speed but economy in fuel.

As we have seen in our preceding sketch, the types of marine engines now in use have been brought to their present state of perfection by a succession of gradual improvements, and have secured several important advantages. For example, about 1881, when the highest pressures did not exceed 90 pounds per square inch, the average coal consumption of steamers at sea was 1·828 pounds of coal per indicated horse-power per hour. The average consumption of steamers now fitted with the triple expansion type of engine does not exceed 1·47 to 1·5 pounds per indicated horse-power per hour. This estimate, in the present absence of systematic returns, has been made on the basis of numerous comparisons between the new and the older types of steam-engines. And this economy in fuel consumption has been accompanied by a greater power being obtained out of a given size of an engine. In 1881 the average speed of the pistons of 39 vessels was 460 feet per second; in other words, they moved up and down that number of feet in the time mentioned. The Atlantic mail steamers have now piston speeds of 900 feet per second, while the Italian ironclad, the *Sardegna*, is fitted with engines which at full power will have a speed of 1,020 feet per second!

As the adaptation of the propeller for utilising this increased development of steam power to which reference has already been made is a matter of prime importance, we must again call attention to it.

Theoretically, a perfect screw propeller would be one so constructed that it would propel a vessel in the direct line of her keel in such a manner as would reduce to an absolute minimum the actual resistance she meets from water in cleaving it. As this would involve blades of the necessary breadth of surface and strength, but without relative friction or thickness, its complete attainment seems impossible. Yet this has been aimed at substantially in all the improvements attempted in the screw propeller since its introduction as a substitute for the paddle-wheel. The nearer, however, this object can be approached, the more perfect the propeller and the more full would be its economical utilisation of the power of the engines driving it.

The latest improvement in this direction has been the adoption of Parson's manganese bronze as a material for "screws" in place of gun-metal and cast steel heretofore used in their construction. Its superiority over the latter is substantially as follows:

It is nearly double the transverse strength of the former, and about equal to that of the best cast steel now made.

As compared with gun-metal, therefore, a great reduction of thickness of the blades by the use of manganese bronze, and a finer, sharper, and therefore a more efficient blade can be produced. Its skin friction, especially on higher rates of speed, is also reduced by the smoothness of surface obtained by the use of bronze manganese.

The upper part of the blades in cast steel propellers have to be made of a sufficient thickness to compensate for the corrosion to which that metal is subject being then most active there. A reduction of thickness here, in consequence of the increased velocity, is most valuable, and it is considerably reduced over their whole surface by the substitution of manganese bronze.

Accuracy in form and such smoothness of surface as they come out of the sand bath as reduces skin friction to a minimum are also characteristics of manganese bronze propellers, as are likewise freedom from pitting and corrosion when in use.

The endurance of a manganese bronze propeller is the same as that of the ship to which it is fitted, whereas cast steel propellers, owing to the weakening of them by corrosion, have to be renewed every two or three years. The reduction in weight of the former also lessens the strain on the stern frame of a vessel in a heavy sea, and if twisted out of shape by collision with a substance harder or stronger than itself the blade can, in most cases, be bent back to its original form by hammering it cold.

The original cost of manganese bronze is about the same as that of gun-metal, but it is roughly about three times that of cast steel. But as "screws" made of the latter have to be renewed say every three years, and including graving-dock charges, and those for labour in fitting them, their original cost in six years will be about the same.

Taking eighteen years as the life of a vessel fitted with propellers of this new metal, their cost could be shown by extending this computation to be about one-half of that of cast steel.

The superiority of manganese bronze propellers over those of cast steel, in connection with increased speed and reduction of coal consumption, is illustrated by the following results of an outward and homeward Australian voyage of the

P. and O. ss. *Ballaarat*, the diameter, pitch, and breadth of surface of the propellers being in both cases the same.

	Speed.	Coal per day.	Indicated Horse-Power.	Slip of Screw.
		TONS.		PER CENT.
Steel Blades... ...	12·11	63·8	2,828	13·1
Bronze Blades ...	12·35	55·0	2,577	9·7

These figures are a mean for the whole voyage, and show an increase of ·24 knots per hour, and a saving of 8·8 tons of coal per day in favour of the manganese bronze blades, or a total saving on the voyage of 715 tons, or about half the original cost of the bronze blades. The displacements and weather were alike on each occasion.

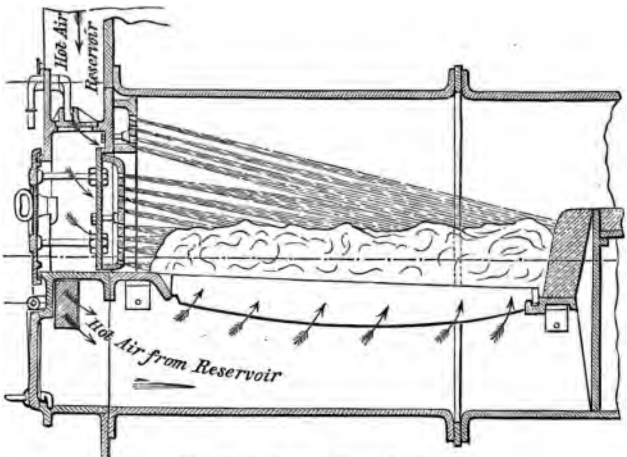
An advantage has also been secured in the new types of engines by reducing their weight, exclusive of boilers, per indicated developed horse-power. In the older type of compound engines this weight varied from 136 to 150 pounds, while, as will be seen from the following table of British warships, it has been brought down as low as 78 pounds per indicated horse-power. The reduction, as will also be observed, has been simultaneously made in the weights of boilers.

VESSEL.	Date.	I.H.P.	Weight of Engines per I.H.P.	Weight of Boilers (including water) per I.H.P.
Canada...	1882	2,430	136	173
Conqueror	1883	5,840	145	166
Colossus	1884	7,490	151	178
Impérieuse	1885	10,180	130	140
Mersey...	1885	6,630	82½	104
Scout	1885	3,370	78	116
Howe	1886	11,725	104	116

Amongst the very latest improvements connected with marine boilers we must not forget to mention the means introduced to supersede or to supplement the natural draught produced by the exit of heated air up the funnel. The object of this invention, the "forced draught," is to enable a greater amount of fuel to be consumed in a grate of a given area than would be possible without the aid of a funnel of undue dimensions. In order to ensure the complete combustion of the fuel when natural draught only is used, it is theoretically required that about thrice as much more air should be admitted to the furnaces for this purpose. As this increase in the supply of air reduces the temperature of the products of combustion, provision is required within the boiler for a greater area of heat-absorbing surface than would otherwise be necessary. Its superiority over a funnel draught is also evident, for to secure a good draught in the latter case there must be a difference of temperature between the gases inside and outside of the funnels of 600 degrees, or 300 degrees above that of the water in the boilers. A given area of heat-absorbing surface should therefore be much more efficient with forced than with natural draught, for the weight of the products of combustion is so much smaller, and its initial temperature very considerably higher.

Two systems of forced draught are at present in use, namely, the "closed stoke-hole" and the closed ash-pit. In the first, which is that in use on war-ships and torpedo-boats, the whole of the boiler-room is made air-tight, and air driven into it by centrifugal fans driven either by a separate or the main engine. The results have been most favourable, for it has increased the indicated horse-power per square foot of fire-grate from 50 to 80 per cent.

In the second system the air is forced into the ash-pit and through the aperture of the furnace-door, the ash-pit being, of course, closed in front. This system has been introduced into mercantile steamers and is identified with the name of Mr. James Howden, of Glasgow, and our woodcut illustrates the manner in which the air was admitted by it above and below the fire in the furnaces. Amongst others Mr. Howden fitted it to a steamer of 3,700 tons displacement at the load draught. With natural draught this vessel had, on her outward voyage, consumed 15 tons of coal per twenty-four hours, and on the home voyage 13½ tons, the engines in the latter case indicating an average of 564 horse-power. When fitted with forced draught she used 11 tons per day on her outward voyage, and on the home voyage 9½ tons, with an indicated average of 623 horse-power.



Howden's Forced Draught System.

Among the incidental advantages of the forced draught system is that it makes the vessel independent of the nature of the wind, for when funnels were relied upon in the tropics it is often very difficult to get any draught at all in calms or slight following breezes. In the close stoke-hole system the boiler hold is always kept cool and well ventilated, thus greatly relieving the exhaustive labour of stoking, especially in hot climates.

We have referred in a previous page to the use of "mild steel" in connection with boiler-making. This was facilitated by the development of steel manufacture which followed the "Bessemer process," by which a carbon, or mild description of the metal, could be produced at about a tenth of the cost of "crucible steel." It was not until 1875-6 that it attracted the attention of our naval authorities, who then ordered from home manufacturers the steel necessary for the construction of the cruisers *Iris* and *Mercury.* In 1879 the Allan Line contracted with Messrs. William Denny & Co. for the building of the *Buenos Ayrean* with steel, and bound together with steel rivets.

Mild steel, from its very first introduction for shipbuilding, found favour with shipbuilders from its being more easy of manipulation than iron. Its cost, however, and the exacting tests of Lloyd's registry, greatly restricted its use for some years. This obstacle to its use was, however, removed by subsequent improvements in its manufacture lessening its cost of production, and the consequent relaxation by Lloyd's of their demands in registering vessels constructed with it.

Amongst its advantages for the construction of ships are its great lightness and strength for strength as compared with iron, as well as economy in labour by its malleability. It is also more easily worked in a cold state than iron, and as it can be more safely flanged along the edges than that metal it enables shipbuilders to do away with angle-bars; and, as we have seen in the construction of the *Paris*, *Teutonic*, and *Campania*, it has also the advantage of being supplied in plates of an increased size.

And then it has the advantage of lightness of weight over all other materials previously used for shipbuilding. For example, the change in that respect from wood to iron saved 30 to 40 per cent. in the weight of ships, and from iron to steel one of 15 per cent. The hulls of ships built of steel may now, therefore, be roughly estimated as being 50 per cent. lighter than were the wooden ones of former days.

The greater safety of steel hulls as compared with those of iron in the diminished risk of damage requiring serious repair in case of their getting ashore, has now brought them into favour with shipowners and marine insurance companies. In fact, through the superior malleability and ductility, and the consequent toughness of mild steel, ships constructed with it have come out of accidents with comparative safety, which would have proved destructive to ships built of iron. Ninety per cent. of the British vessels are now made of mild steel. For example, in 1891, 249 steamships, aggregating 503,015 tons, were built of it, against 82 vessels of iron, aggregating 13,132 tons, and 3 vessels, of a total of 160 tons, of wood. And the same holds good of sailing ships, for in 1891 there were 100 built of steel, aggregating 179,886 tons, against 6 built of iron, with a total of 2,480 tons.

Some reference is called for here, also, to the variation in the proportion of beam shown by the several builders of these large steamers, and to which attention has recently been called by that high authority in such matters, *Engineering*. The *Oregon*, for example, it points out, had more beam relative to length than the *Arizona* and *Alaska*. The *America*, on the other hand, was built on the principle of continuing the development of speed without adding so much to the dimensions of the vessels as to increase the expenditure involved in working them. The same idea seems to have suggested the *Britannia* and *Germania* to Sir Edward Harland. With Messrs. J. & G. Thomson the desideratum was to reduce displacement and the immersed area of the ship in order to minimise resistance. They therefore determined to make the ship short, but of great proportional beam to length and with a flat floor. In the *Aurania* this was partially carried out, for her beam was 8·24 to 1. In the *America* it was 8·47; but in the *Oregon* the breadth of beam to length was extended to 9·259, and this proportion was followed in most of the succeeding vessels, excepting in the instances of the *Teutonic* and of the *Majestic*. None of these later vessels, excepting the latter, approach a proportion of ten feet of length to one foot of beam, for very few exceed nine feet. The *Campania* and *Lucania* follow generally in the lines of the recent Fairfield vessels, having a proportion of 9·23.

It is also interesting to note that speed was not sought for in these newer ships at the expense of cost in working. The *Alaska*, while having a boiler pressure of 100 pounds to the square inch, against the 90 pounds of her competitors, when ready for sea had 3,000 tons less displacement. She had more powerful engines than they had, for they reached to 1·514 indicated horse-power per ton gross. On her best homeward record her speed was 17¼ knots, to attain which she burned 253 tons of coal per day, or in a run of 430 knots, about 11¾ cwt. per knot. The *Teutonic* and *Paris* cover a greater distance in the twenty-four hours; their greater ratio of power, however, counterbalances the advantage of their more economical triple expansion engines, for their coal consumption is but 2 cwt. less than in the case of the *Alaska*. These and other associated facts have suggested to *Engineering* the following particulars, which are so interesting that we quote them.*

—	*Britannia,* 1840.	*Persia,* 1856.	*Gallia,* 1879.	*Umbria,* 1884.	*Campania,* 1893.
Coal necessary to steam to New York—tons	570	1,400	836	1,900	2,900
Cargo carried ... „	224	750	1,700	1,000	1,620
Passengers	115	250	320	1,225	1,700
Indicated horse-power	710	3,600	5,000	14,500	30,000
Pressure—lbs.	9	33	75	110	165
Coal per indicated horse-power—lbs. ..	5·1	3·8	1·9	1·9	1·5
Speed—knots	8·5	13·1	15½	19	22

"In 1840 the *Britannia* burned 2·4 tons of coal on the voyage for each ton she carried, and took over fourteen days; the *Persia*, in 1856, burned nearly two tons of coal for every ton carried, crossing in about ten days; the *Gallia*, in 1879, built with large cargo capacity, burned less than half a ton of coal per voyage for every ton delivered, accomplishing the voyage in about eight days; and the *Umbria*, in 1889, consumed two tons per voyage for each ton of cargo, crossing in slightly over six days; while the new steamers, notwithstanding that they have more economical engines, will burn as much relative to cargo as did the *Umbria*. The two new vessels, like the *Umbria* and *Etruria*, are distinctly for passenger trade, and only carry a limited cargo, so that the result is satisfactory. For every cabin passenger carried the *Britannia* burned per trip 4·7 tons of coal; the *Persia*, 5·1 tons; the *Umbria*, 3·8 tons; but the *Campania* and *Lucania* will only burn about two and three-quarter tons. Moreover the latter vessels carry a large number of steerage passengers, and the last-named boats will cross in less than half the time taken by the first-named."

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* *Engineering*, April 21st, 1893, p. 469.

There may, however, be changes in the kind of fuel used for making steam. Coal is almost universally used for the purpose, the only exception being that of petroleum in certain districts where it is largely and cheaply available. All the steamers on the Caspian Sea burn only petroleum refuse, as likewise do the railway locomotives in Southern Russia. Its advantages over coal are: less bulk occupied on board ship, greater ease in shipping, and a greater evaporative power for a given weight. As it is supplied to the boilers mechanically, it does away entirely with the labour of stoking.

Some have imagined that electricity, because it is now effectively used as a motor on railways constructed for the purpose, may yet be employed for the propulsion of large vessels by an increase of its power. But we know comparatively too little of this subtle agent to enable us to come to any definite conclusion on the subject. What we do know, however, suggests the presumption that it may yet be used efficiently for the production of heat on so large a scale, and so economically, as may at some not distant future period lead to its being used as a substitute for coal.

The improvements already made in steam marine propulsion naturally lead us to anticipate further similar, or even greater, results in the future. That already attained has been chiefly through those made in the construction of boilers. Although something may yet be done in the way of rendering the engine proper more economical of steam, it is generally felt that the next great step in advance will be in still further perfecting these steam generators, and for the following reasons.

Theoretically, a pound of good coal should, in use, evaporate fourteen pounds of water, by raising its temperature to 212 degrees Fahrenheit. But only about eight pounds at the outside are evaporated by it, the remainder of its heat product being wasted by imperfect combustion, in radiation, and also, as has been shown, in creating the draught for the furnaces. This, then, is the problem engineers have to solve. They may, possibly, save another two or three ounces of coal per indicated horse-power; but in the boiler a margin of something like half a pound of coal in the indicated horse-power remains for them to work upon. Or, to put the matter more plainly, the best engines of to-day consume, very approximately, about twelve pounds of steam per horse-power, which requires the consumption of one and a half pounds of coal to evaporate, but which it is possible might, under more favourable conditions than those now supplied in our boilers, be evaporated with one pound of coal.

We have thus sketched in outline, for our readers, the progressive improvements made up to the present time in marine engines and boilers and in the screw propeller, and must leave them, when at sea, by a descent into the engine-room and stoke-hole, to make such personal examinations as will enable them to fill up the blanks thus left in our description.

CHAPTER XVIII.

The North Atlantic viewed as a region traversed by our Ocean Railways.

A NECESSARY complement to a description of a land line of railway is that of the region it traverses. Although from an engineering point of view this is all-important, it is not obviously so absolutely necessary in the employment of steam as a locomotive on the ocean. A journey is rendered more or less interesting according to its scenic attractions, and our various land lines utilise such attractions in advertising for passengers. We therefore venture to add to our history of the rise and progress of our Ocean Railways a description of that portion of our globe traversed by them.

Although their lines have been extended over all seas, the North Atlantic was, as we have seen, the cradle of ocean steam navigation, for on its stormy waters the propulsion of vessels by steam was proved as possible and feasible as upon our placid inland rivers and lakes.

Five centuries ago this ocean, as already stated, was enshrouded in mystery, and even until recently has been largely looked upon by landsmen as a region marked by dreariness and monotony. Dangers also, and discomforts are associated with it by those contemplating a sea voyage. In the days of sailing ships, this feeling was more extensive than it is now, for men then made their wills. This state of feeling towards the ocean is a very ancient one, for Horace, in his day, when its navigation was more limited in its range than in our later days, wrote these despondent lines on the subject:

> Cœlum non animam, mutant qui
> trans mare currunt,

and which have been thus poetically paraphrased by Surgeon-Major Graves-Irwin:

> Who traverse many seas
> And change their skies and places,
> For them no change doth please
> Of landscape, forms or faces;
> Their souls while bound to roam
> In bodies, wave be-tost,
> And all its pleasure lost!

But this is only the dark side of the picture. It has a brighter one, for a writer older than this Latin author has told us that "They who go down to the sea in ships, and do business in great waters, these see the works of the Lord and his wonders in the deep!"

"For myself," wrote a ship captain to Captain Maury, "I am free to confess that for many years I commanded a ship, and although never insensible to the beauties of nature upon the sea or land, I yet feel that until I took up your book* I had been traversing the ocean blindfold; I did not think—I did not know the amazing and beautiful combination of all the works of Him whom you so beautifully term the 'First Great Thought.'"

The ocean is a new world to the cultivated mind when it is first spread out before it. In its various phases of storm and calm, its currents and depths and other characteristics will lead to the study of the laws by which they are regulated. The stolid land is barren indeed compared with the living, moving waters of the great deep.

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* "The Physical Geography of the Sea."

How varied, for instance, are its colours under different effects of light on its surface! When the gentle zephyr raises ripples of tiny waves, it becomes the silver sea of which Homer sang. In certain states of the sky, and at certain hours of the day, when off soundings, it is either dark blue in appearance, or brown or inky black. When holding in solution an extra percentage of salt, as in the Mediterranean or Sargasso Seas and the Gulf Stream, it assumes a bright cobalt or dark indigo blue. On soundings, where the bottom is bright-coloured, it becomes a light emerald green.

It is sometimes so calm that its surface has a glassy appearance. At others it is disturbed by long rolling waves, the precursors of an approaching gale, or the after consequences of one which has passed away. Under the influence of a fresh breeze, its white-crested waves and the bright sunshine present a scene no painter, however skilful, could imitate. But when, again, the Storm King lashes its waters in his fury, and its waves rise to kiss his feet, then a scene of the wildest grandeur ensues. Here power and motion combine to awe the beholder, for, in the language of the Psalmist, "He commandeth and raiseth" (or as in the margin, "*maketh to stand*") "the stormy wind, which lifteth up the waves thereof. They mount up to the heaven, they go down again to the depths; their soul is melted because of trouble. They reel to and fro and stagger like a drunken man, and are at their wits' end" (or as in the margin, "*all their wisdom is swallowed up*").

Our North Atlantic ocean railways traverse a rough country over deep cuttings, bridged by a kind Providence by one of the four elements formed of a specific gravity which made their construction possible. Let us now look at that dividing Europe from North America, in illustration of which we give our readers a map compiled by Captain Maury, from soundings by the American Navy.

He describes this basin of the Atlantic in its entire length as being "a long trough separating the old world from the new, and extending probably from pole to pole," and "scored," as he remarks further, "into the solid crust of our planet by the Almighty hand, that there the waters which" he called seas, might be gathered together, so as to "let the dry land appear."

If it is important and interesting to lay down on our maps the mountain ranges of the earth, it is equally so in bringing the physical geography of the sea within the domain of science. We thus present its orography, by mapping out its bottom so as to show the depressions of the solid parts of the earth's crust there below sea-level. As the result of this we have the map referred to.

It represents the bottom of that part of the Atlantic Ocean lying north of 10° south latitude. The four shades with which it is marked indicate its varied depths; the darkest indicating where the water is less than 6,000 feet deep; the next where it is less than 12,000 feet; the third where it is less than 18,000 feet; and the fourth where it is not over 24,000 feet deep. South of Nova Scotia and the Grand Banks, the space is left blank over a district within which very deep water has been reported, but the casts for soundings of the deep sea-lead have not been regarded as sufficiently satisfactory to be noted. The deepest place in it, however, is believed to be between the parallels of 35° and 40° north latitude, and immediately south of the Grand Banks of Newfoundland. One place so regarded has the shape of a boot on the map. How-deep this place is yet remains to be determined. From the summit of Chimborazo to the bottom of the Atlantic, the distance in a vertical line is nine miles.

We also give our readers another plate from the same source of a vertical section of the North Atlantic, showing the remarkable and interesting contrasts of its bottom with the sea-level in a line from Mexico across Yucatan, Cuba, San Domingo, and the Cape de Verds to the coast of Africa.

Between Cape Race and Newfoundland and Cape Clear in Ireland is a steppe which has come to be known as the "telegraphic plateau." The great circle distance over it between the eastern shores of Newfoundland and the western shores of Ireland is 1,640 miles.

We are indebted to the Hydrographical Department of the Observatory at Washington for the discovery of this plateau. In 1849 a law was passed by the American Congress directing the Secretary of the Navy "to detail three suitable vessels of the Navy in testing new routes and perfecting the discoveries made by Lieutenant Maury in the course of his investigations of the winds and currents of the ocean, etc."

With the soundings thus secured Maury was enabled in the fall of 1852 to construct an orographic map of the bed of the North Atlantic Ocean, and to give a vertical section of its bottom in profile between North America and Europe near the parallel of 39° north. The "telegraphic plateau" is shown on our map very much as subsequent deep-sea soundings then proved it to be.

Up till this period, 1852, nothing had ever been brought up from the bottom of the deep sea, when a sounding apparatus was contrived by Lieutenant Brooke, of the American Navy, for bringing up specimens from great depths, and which bears his name. The first time it was used was in July, 1853, in latitude 54° 17′ north, longitude 20° 33′ west.

This sounding was made, as all subsequent ones were, from a boat, and occupied six hours. The depth was 2,000 fathoms, or a little under a mile and three-quarters! The apparatus brought up precious trophies, which, with other specimens from the bottom of the great deep brought up by this apparatus, were submitted to Professor Bailey for microscopical examination. Not a particle of sand or gravel was found to have been mixed with them, and they were also found to be "mites of sea-shells, perfect in form, and as unworn and untriturated as when their occupants were alive."

This, as Maury remarks, "suggested the idea that there was no running water nor abrading forces at play upon the bed of the deep sea, and consequently, if ever an electric cord were lodged upon the telegraphic plateau, there it would lie in cold abstraction; without anything to fret, chafe or wear, save alone the tooth of time."

Accordingly in February, 1854, when the projectors of the Atlantic telegraph asked him "about the practicability of submerging the cable," he described the suitableness of this plateau in being "neither too deep nor too shallow, yet so deep that the wires being once landed will remain for ever beyond the reach of vessels' anchors, icebergs, and drift of any kind, and so shallow that wires may be readily lodged upon it."

And so, as we know, the cable was laid, followed by others which in their continued use have confirmed the views expressed to Mr. Morse and his associates on the feasibility of the project, the possibility of which, however, was dependent on the use of steam as a propelling power in the vessels which laid that cable.

We have also a new and very striking inference deduced from the shells brought up from great depths by Brooke's apparatus, from many, even of the most diminutive of them, being seen under the microscope still to retain the fleshy parts of their inhabitants. This Maury regarded as one of the most beautiful and suggestive facts which the new system of deep-sea sounding had revealed. "We roam with it," he further states, "through the realms of conjecture, and fancy that the sea embalms its dead, that all the corpses which have been committed to the deep in 'blue water' with weights attached are now standing on the bottom, their lineaments and features as perfect as the day on which their comrades were called to bury the dead!"

In another place he remarks that the pressure on the telegraphic plateau varies from 430,000 to 650,000 pounds to the square foot. Chemical forces may be overcome by pressure, for the gases generated by chemical decomposition can only in the process of decomposition exert so much pressure, and hence if we subject them to a greater one they cannot separate, and consequently decomposition cannot take place. Shells obtained at a great depth in the Mediterranean were discovered under the microscope by Ehrenberg to be fresh-water shells, and therefore not native or natural habitants of the locality in which they were found.

Maury turns this interesting fact to account in answering the question as to whether the gutta-percha used for insulating submarine wires becomes impervious to decay, and answers it in the negative.

As a full description of the wonders of the deep would require a separate treatise, we must refer our readers to Maury's "Physical Geography of the Sea," "The Cruise of the *Challenger*," and other interesting sources of information on the subject, contenting ourselves with only a glance at a few of the most striking of them.

We therefore call their attention first to that river in the ocean which in the most severe droughts never fails, and in the mightiest floods never overflows. Its banks are cold, while its stream is warm. The fountain from whence it flows is the Gulf of Mexico, and it has its mouth in the Arctic Seas. The Amazon, and the Mississippi, and the St. Lawrence are great rivers, but none of them can be compared either in the rapidity of their currents nor in the volume of their waters with this river of the ocean.

As far as the coast of the Carolinas its waters are of an indigo-blue colour, but so distinctly marked that their line of junction with their boundaries of common sea-water is at once discernible to the eyes. This difference of colour is accounted for by the well-known fact observable in the process of the solar evaporation of the latter in the series of vats or pools at the salt-works in France, along the shores of the Adriatic, and elsewhere in Turkey. The longer it is exposed to evaporation, the salter it naturally becomes and the deeper is the shade of its blue. An interesting example of this is the appearance of the Dead Sea, which, with one exception, is the most salt water in the world. Looking down upon it from Bethany its colour is a very dark indigo-blue. The greener the hue of sea-water, in the opinion of those salt makers, the fresher is it, and hence the colour of the Baltic is in this respect in marked contrast with that of the Atlantic, for it holds in solution only half the quantity of salt held in solution by the latter.

Tried by most delicate instruments, the water of the Bay of Biscay was found to contain $3\frac{1}{2}$ per cent. of salt. In the trade-wind region, where solar evaporation is very rapid, it was $4\frac{4}{10}$ per cent., and in the Gulf Stream off Charleston it was 4 per cent., notwithstanding the dilution of the waters of the basin by those of the Amazon, Mississippi, and intermediate rivers, and from the rain-clouds of the West Indies.

The Gulf Stream is a rather phenomenal river in another respect, because for a part at least of its course it runs uphill! Its breadth in the Florida Pass is thirty-two miles, its velocity four knots an hour, and its depth 370 fathoms. Off Cape Hatteras its breadth is about seventy miles, its mean velocity three knots an hour, and its depth 114 fathoms. Consequently, instead of descending as it issues from the Gulf of Mexico, its bed represents an inclined plane ascending from the south towards the north, up which the lower depths of the stream must ascend!

This phenomenon has been sought to be explained by the supposition, that as in the Sea of Tuscany, the surface of which has been known by "gusty gales" from the S.W. to have been raised twelve feet, the Gulf Stream is the escaping of water in the Caribbean Sea forced into it by the trade-winds.

The accumulated water of the Sea of Tuscany occasions a strong surface-drift through the Strait of Bonifacio. But it does not flow, like the "river in the ocean," through a well-defined narrow channel across the Mediterranean, but spreading out as soon as it finds sea-room after it emerges from the straits, loses itself by the extension. Although in the present state of our knowledge two causes may be safely assumed as in operation among others in producing the Gulf Stream. One is the increased saltness of its waters after the trade-winds have been supplied with vapour from it, and the other the diminished quantum of salt which the Baltic and Northern Seas contain. In one of these basins, that swept by the trade-winds, the water is heavy, and in the other, that of the seas named, it is light. The ocean intervenes between them, but water is bound to maintain its level, and here is unmasked one of the agents in causing the Gulf Stream. The salt which the trade-wind vapour leaves behind it in the tropics has to be mixed up, and this is doubtless one of the offices which in the economy of the ocean has been assigned to the Gulf Stream.

But why do the waters of the Gulf Stream, with a specific gravity greater than that of the waters through which it flows, not disappear beneath them? The reply is that its temperature prevents its doing so.

Off Hatteras and as high as the Grand Banks of Newfoundland in mid-ocean there is a difference of temperature of from 20° to 30° between its waters and that of the ocean. Water we know expands by heat, and this difference of temperature may more than compensate for the difference in saltness, leaving the lighter water of the Gulf to float over the colder waters through which it passes.

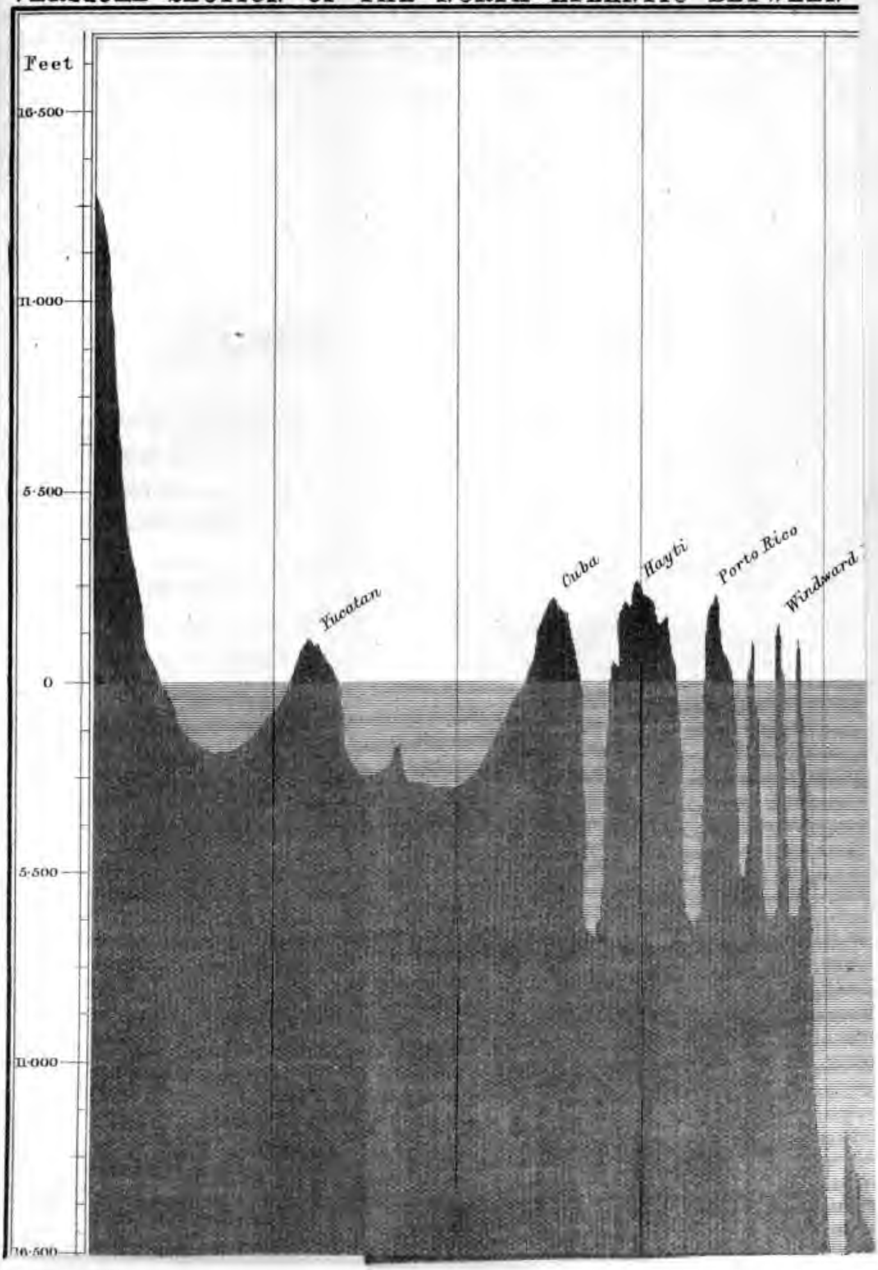
If the waters of the Gulf Stream are lighter, they should, as Maury observes, occupy a higher level than those through which they flow. Hence he concludes that the middle of it should be nearly two feet higher than the contiguous waters of the Atlantic, and that its surface should present "a double inclined plane," from which the water would run down on either side. As this runs off at the top, the same weight of colder water comes in at the bottom, and the stream thus becomes shallower as it goes north.

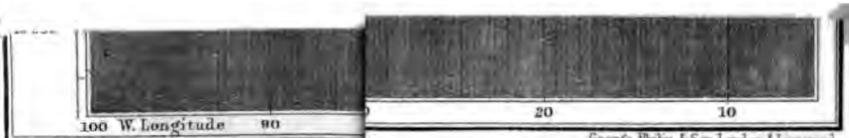
Navigators drifting along the Gulf Stream, when they had lowered a boat to try its surface current, have found it drift either west or east, as it happened to be on one side or the other of the axis of the stream. Thus it is that seaweed and driftwood are found in such large quantities along its outer edge, and are rarely found along its inner one even during the prevalence of easterly winds. To cross the Gulf Stream from one side to the other they would have to stem the roof-current we have described until the middle of the stream was reached. It is rarely that planks, or wrecks, or any floating substances cast into the sea on the eastern side of the Gulf Stream are found along the coast of the United States, while driftwood, trees, and seeds from the West Indies have been cast up on the shores of Europe.

But this may further be accounted for by the diurnal motion of the earth. It is well known to engineers, for example, that a railway train going north has a tendency to run off on the east side, and when going south on the west side. The driftwood floating down the Mississippi, which flows south, is apt to be cast on the west side. Now, *vis inertia* and velocity being taken into account, the tendency to yield to this diurnal rotation, and therefore to trend to the right, as in a railway train running north, is proportionately as great as in a patch of seaweed as it drifts along the Gulf Stream.

While the Gulf Stream is running to the north, there is a cold current coming from the north meeting the warm waters of the former midway in the ocean. The latter then divides itself, and one part of it runs under the Gulf Stream, as is evidenced by the icebergs which are carried in a direction tending across its course. This "fork" probably flows south into the Caribbean Sea, for the temperature of the water there, at no very great depth, has been found to be quite as cold as at a corresponding depth off the Arctic shores of Spitzbergen. The other fork runs to the south between the American coast and the Gulf Stream, and so far as it can be traced warrants the belief that it runs into the Gulf of Mexico. This Arctic current has for its office the restoring of the equilibrium of the water in the torrid zone, destroyed by the issue from it of the Gulf Stream, its specific gravity being increased through its contraction by cold.

VERTICAL SECTION OF THE NORTH ATLANTIC BETWEEN





George Philip & Son, London & Liverpool.

CHAPTER XIX.

The Great River of the Atlantic, its source and early effects upon navigation and commerce, and the present railway precision with which that ocean is now crossed.

THE Gulf Stream trends more and more to the eastwards until it reaches the Banks of Newfoundland, when its course becomes nearly due east. But it cannot be affirmed that these Banks deflect it from its proper course and turn it eastwards, for they are apparently more of an effect than a cause, as the frigid current from the north already referred to here meets the warm waters of the Gulf Stream, which melt the icebergs which it brings with it. The earth, stones, and gravel borne on them being consequently deposited there have gradually formed these Banks.

Captain Scoresby, when far away north, counted 500 icebergs sailing out south thence on this cold current; many of which were loaded with earth. The author crossed this current in an Allan Line steamer some years ago, and from daylight until sundown, when the Straits of Belleisle were entered, no fewer than 110 were counted from the bridge, a number of which were similarly laden. It seems, therefore, probable that these Banks were formed in the course of ages by these agencies.

This view of the formation of these Banks has been confirmed by the soundings made by vessels marked on the Plate chart which we give our readers. The greatest contrast in the depths measured is immediately south of them. Nowhere in the open sea has the water been found to deepen so suddenly as here. This is particularly the case in the spot of boot-like shape, just south of the great Bank. Coming from the north the bottom of the sea shelves as we go south, until just beyond the Banks, when its depth suddenly increases, dropping many thousand feet almost perpendicularly. This would seem to confirm the notion that the Banks have been formed by this débris of earth and rocks brought by the icebergs floating south. The following fact, not generally known, indicates that this deposition is still going on. The soundings on the Admiralty chart for that part of the sea north of the Banks, obtained by surveys early in this century, have decreased considerably. The late Captain Dutton, of the Allan Line, first called the attention of the author to this fact when making a voyage with him on the *Nestorian* some years ago. The region of ocean referred to is crossed by steamers entering the St. Lawrence by the Straits of Belleisle. Other of their captains of the line have confirmed his observations.

The course of the Gulf Stream towards the British Islands, so far as it can be traced, describes the arc of a great circle, or nearly that which would be followed by a cannon-ball fired in that direction from the Straits of Bemini. The path actually described by the ball would be the resultant of the difference in the rate of the diurnal rotation of the earth and the projectile force, the former impelling it to the east, causing the ball to describe a great circle. We may assume it as a law, that the natural tendency of all currents in the sea, like that of all projectiles through the air, is to describe their curves of flight in the planes of great circles, which, as we have seen, is done by the Gulf Stream. It is bound over to the North Sea and Bay of Biscay partly because its waters are lighter than those

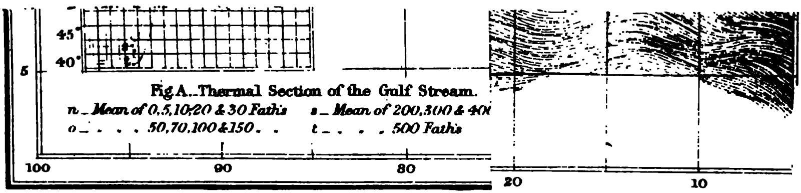
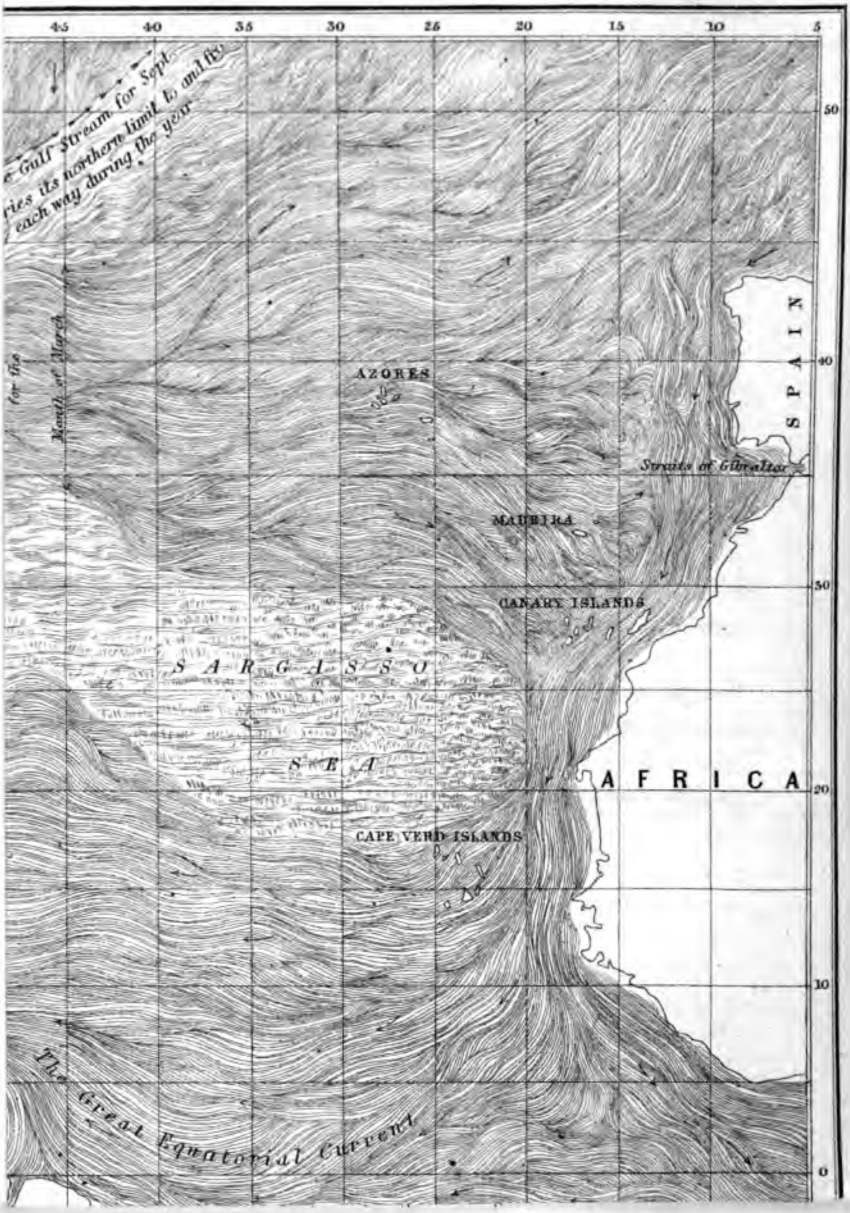


Fig. A. Thermal Section of the Gulf Stream.

n _ Mean of 0, 5, 10, 20 & 30 Fath's s _ Mean of 200, 300 & 40

o _ . . . 50, 70, 100 & 150. . t _ . . . 500 Fath's

George Philip & Son. London & Liver


45
40
35
30
25
20
15
10
5
50
40
30
20
10
0
e Gulf Stream for Sept.
ries its northern limit to and fro
each way during the year
for the
Month of March
AZORES
SPAIN
Straits of Gibraltar
MADEIRA
CANARY ISLANDS
SARGASSO
SEA
AFRICA
CAPE VERD ISLANDS
The Great Equatorial Current

of the Mexican Gulf, and it could not pursue a more direct route to reach them. As the Grand Banks are, however, encroaching southwards, the cold currents which come down upon it from the north may probably assist now and then to turn it aside.

If the foregoing explanation as to the direction of the Gulf Stream and its eastern tendency is correct, a current setting towards the south from the north should have a westerly tendency. It should also move in the circle described by a trajectile. Accordingly we find the current from Baffin's Bay and Davis Straits, which meets the Gulf Stream at the Grand Banks, taking a south-westerly direction. It runs down to the tropics, where it is bound by the side of the Gulf Stream, drifting as far west as the American shores will allow.

There are, however, other forces operating upon the Gulf Stream growing out of the changes in the waters of the whole ocean, produced by alterations in their temperature. When it leaves the American coast it begins to vary its position, according to the season of the year. In winter its northern limit as it passes Cape Race is about 40–41° north latitude, but in September, when the sea is hottest, it is about latitude 45–46° north. As Captain Maury remarks, the length of the Gulf Stream may therefore be supposed to waver about the ocean, not unlike a pennant in a breeze, with "its head confined between the Bahamas and the Carolinas."

Our plate of the Gulf Stream illustrates this change in the position of its channel. The diagram A shows the thermometrical profile of a cross-section of the stream based upon observations made by the staff of the United States Hydrographical Survey detailed for the service.

It would be interesting to have followed here the physical effects of the Gulf Stream in modifying the climate of the

North Atlantic, and those of our own islands, and of Northern Europe, as well as in other important directions. Our limits, however, oblige us to refer our readers for further information about the influence thus exerted by this "river in the ocean" to the works to which we have already referred them.

Navigators in the North Atlantic were not practically aware of the existence of the Gulf Stream until towards the close of the last century, when attention was called to it under the following circumstances.

When Dr. Benjamin Franklin was in London in 1770, he was consulted by the Lords of the Treasury about a memorial sent to them by the Board of Customs of Boston, Mass., stating that packets sailing from Falmouth were generally a fortnight longer in making their port than were the common traders from London to Providence, Rhode Island. They therefore asked that the Falmouth packets might be sent to the latter port instead of to Boston.

This naturally excited the curiosity of Franklin, for it appeared strange to him that the longer voyage from London should be made in a less time than the shorter one from Falmouth. Meeting the captain of a Nantucket whaler, who happened to be in London at the time, he was informed by him that Yankee captains sailing from the Thames were acquainted with the Gulf Stream, while those of the English packets were not. The former wisely kept out of it, while the latter, who kept in it, were set back sixty or seventy knots a day by its current. He had himself been made acquainted with the stream by finding whales on either side, but never in it, as they avoided its warm waters.

At Franklin's request this Yankee captain traced from recollection the course of the stream on a chart, which the Doctor had engraved at Tower Hill, and with copies of which he supplied the Falmouth captains. They, however, paid no attention to it, but followed their old courses.

The course of the Gulf Stream as thus laid down by the Yankee whaler has been retained, with only a few trifling modifications, and quoted in charts for navigating the North Atlantic since then until the present day.

Though navigators had been in the habit for three centuries of crossing and recrossing the Gulf Stream, and from imperfections in the Nautical Ephemeris and in their instruments of observation had often been very dangerously out in their longitude, yet it never occurred to them to use as a guide the sharply-defined western edge of the Gulf Stream, which never changed its position as much as they erred in their reckoning.

According to Franklin's discovery with regard to the temperature of this stream, it was regarded by him as one of great importance because of its serving as a beacon, guiding mariners to the American coast in all weathers. A prize of £20,000 was offered and partly paid to Harrison, the chronometer maker, for improving the means of finding longitude at sea. So far as the North Atlantic was concerned the object had been to some extent attained, for on approaching the American coast, the current of water in the Gulf Stream and the cold water on its western side, if tried by the thermometer, would enable the ship captain to judge his position even in the worst of weather.

Although Franklin made his discovery in A.D. 1775, the American Colonies were then in rebellion, and for political reasons—that is, to prevent the too easy approach of British cruisers to the American coast—he did not make it generally known until A.D. 1790. Its immediate effect was to make the northern ports of America as accessible in winter as in summer, shortening the average passage from England from upwards of eight weeks to a little more than four. This improved transit across the Atlantic was without doubt one of the causes of the rapid increase in the American trade with Europe, for its total exports and imports, which were in A.D. 1791 only 14,480,116 dollars, rose in A.D. 1796 to 63,655,238 dollars. It had also the effect of drawing the trade from Charleston, S.C., to northern ports, which had thus been rendered more easily accessible to vessels from Europe. Philadelphia, New York, and Boston may therefore be regarded as having thus attained their present commercial supremacy in no small degree owing to the Gulf Stream and the water thermometer.

The consequent rapid augmentation of its population by emigration from Europe, chiefly from the United Kingdom, together with the rapid development of the trade and commerce of the United States, and of its rich territorial resources, required *pari passu* with it increasing and improved facilities for oceanic transport between them and the old world. In the preceding pages we have traced this increase and improvement until it culminated, as we have seen, in the triumph of steam as a propelling power over the fickle winds. There was at first no path known across the desert of waters between the two continents until Columbus had opened one. Then the path was more clearly marked, and gradually widened. Then something resembling what occurred on land before the introduction of railways occurred. First, rough country roads, over which the traffic of the country was drawn by horses; then macadamised turnpikes; and last of all the railway and the steam locomotive. Ships were gradually improved in structure, and then the instruments of navigation.

A hundred years ago ship-masters on a voyage from the British Islands to America guessed as much as calculated the place of their ships. If bound for Boston, Massachusetts, they did not by any means regard it as a bad land-fall to make New York, which they frequently did, and no wonder, for their instruments of navigation erred quite as much by degrees as they now do by seconds. In fact, instances then occurred of vessels sailing across the Atlantic being from 6° to 8° and even 10° of longitude out of their reckoning in as many days from port.

Chronometers were then but an experiment, and the tables of the Nautical Ephemeris involved errors of thirty miles in longitude in working out an observation. When the rude "cross staff" and "back staff," the "sea ring" and "mariner's bow" gave place to the more accurate sextant and circle reflection, more accurate observations were secured. Our Nautical Almanac, in the mathematically precise astronomical information it provides, together with perfected chronometers, have secured to the mariner absolute certainty as to his position.

But, however certain the master of a sailing ship might then be as to his position on the North Atlantic, he was ordinarily uncertain when he might be able to reach his destined port. He might encounter baffling winds or none at all, or encounter head gales which would either drive his barque to Arctic limits, or well up in the direction of the West Indies. Steam now has done away with this uncertainty. The course is laid from day to day, and often for parts of a day, and followed to a point of the compass, until the destined port is reached. And so regular have these Transatlantic passages become that on all of our regular steam lines the arrival of certain of their steamers is calculated by hours, and hence our designation of these lines as Ocean Railways.

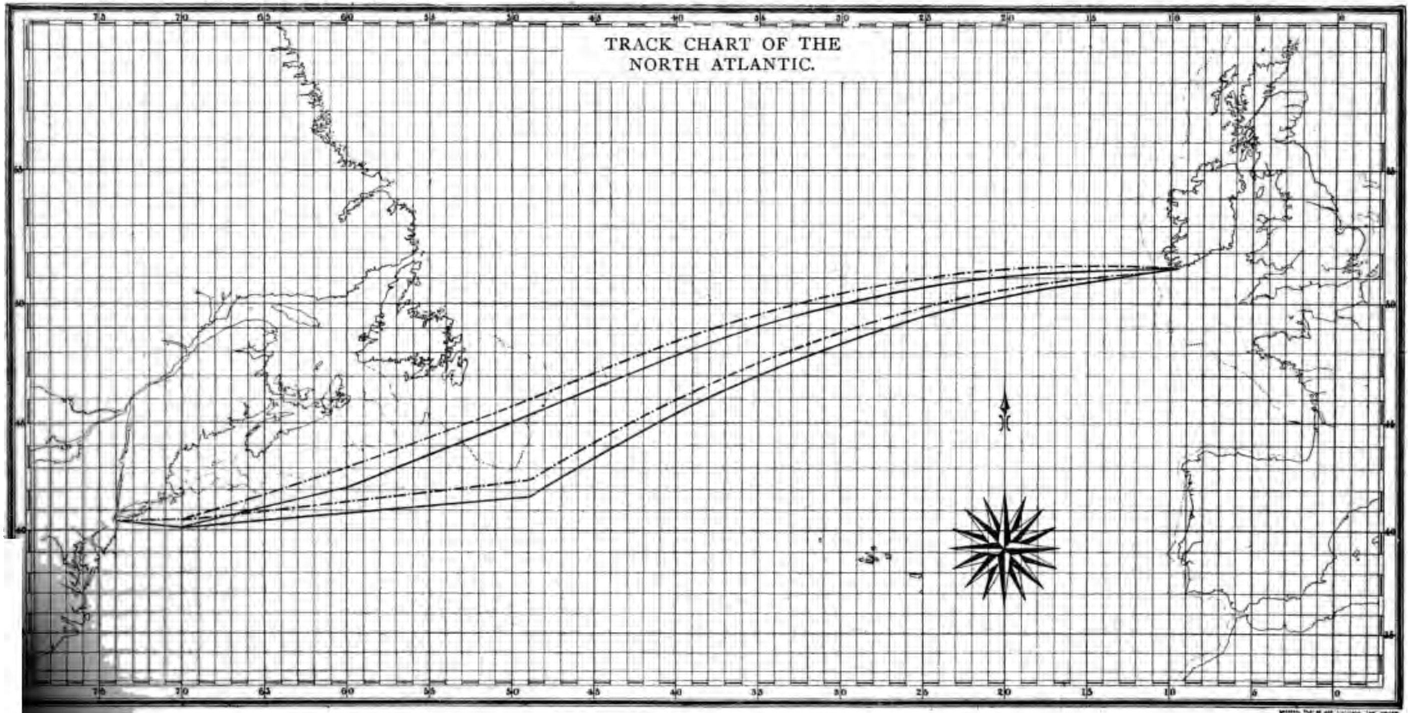
On all the main routes on Ocean Grand Trunk Lines, such, for example, as the express service between Liverpool and New York, certain well-defined tracks are followed, as shown in the accompanying Track Chart of the North Atlantic. In place of rails and ties, as in the case of land railways, we have latitude and longitude, and what is known to the navigator as great circle sailing. He is enabled to follow the lines thus laid down by his compass, sextant, and chronometer, and the other aids with which he has been supplied by science and experience. These not only help keep him on the track, but inform him on it. When the sun and stars are covered by clouds, or shut out by fogs, he judges his position more accurately than the master of a sailing ship could do, for his propelling power incessantly keeps him on a straight course, and his patent log, checked by the revolutions of the "screw," indicates how far he has proceeded along it.

The two northern tracks on the chart are those followed by outward-bound steamers from Liverpool. That marked in a dotted line is followed from July 14th to January 15th, runs on the great circle course until it reaches 49° west longitude, which it crosses in 46° north latitude, and 70° west longitude in 40° 30′ north latitude, and thence to Sandy Hook.

The dotted line to the south marks the track of steamers homeward bound. Leaving Sandy Hook it crosses 70° west in 40° 10′ north, and 49° west in 42° 30′ north, and thence by the great circle course to the Fastnet.

The two continuous lines on both routes indicate the tracks followed during the ice season, that leading to the west crossing 50° west longitude in 45° north, and that to the east crossing 49° west 41° 40′ north. Both ice tracks cross 70° west in 40° 10′ north.

The bergs generally put in an appearance in February and


TRACK CHART OF THE NORTH ATLANTIC.

disappear in August, but in some years are met with in October and November. The greater number of them come from West Greenland, and are fragments of glaciers which fall into deep water along the shore. Many thousands of these glacier fragments drift southwards. Others ground in the Arctic basin, and fall to pieces. Some float towards Labrador, and share a similar fate, or melt away.

When liberated in July or August, icebergs in drifting south do not reach the steamer tracks until December and January. Many, however, float about many months later, and often for years, from their immense size, before they do so. In fact, their movements are so variable that no absolute reliance can be placed on their appearance, for it may occur earlier or later in consecutive years. In order, however, to reduce the danger to which steamers on these fixed routes are exposed from them, the ice-tracks referred to have been laid down.

Several of our express liners have had narrow escapes from collision with these ice-mountains, four-fifths of which are under water. Amongst these was the *Arizona*, which, by striking one of them in a fog when going full speed, stove in her bows for thirty feet. The smoothness of the sea and the strength of her forward bulwarks, however, enabled her to reach St. John's, Newfoundland, in safety.

To the two principal currents in the North Atlantic already mentioned must be added the Equatorial current, which, with that called the St. Rocque, or Brazilian current, flowing southwards, has its source in the warm waters about the equator, between Africa and South America.

The former receiving on its way north the Amazon and Orinoco as tributaries, and with waters rendered more briny from the vapours collected by the trade-winds leaving their salts in them, it flows into the Caribbean Sea and becomes the great feeder of the Gulf Stream.

Another current from the Polar regions east of Greenland flows southwards along the coasts of Europe and Africa. Ten degrees or so north of the Equator an offset from it flows almost direct to Cape St. Rocque, and thence along the coast of Brazil. An offset from the Gulf Stream curves near Madeira, and, forming the Equatorial current, flows back with it into the Gulf of Mexico, forming a great whirlpool in mid-Atlantic, with the Sargasso Sea as its vortex.

This centre of the great whirl of waters, the Sargasso Sea, forms the triangular space between the Azores, Canaries, and the Cape de Verde Islands, and is so thickly matted over with seaweed as to retard the speed of vessels passing through it. When Columbus and his companions saw it on his first voyage, they became alarmed, for they thought it marked the limits of navigation in that direction. And there this mass of weeds has remained until this day, moving up and down, and changing its position according to the seasons of the year, and as the storms and winds move it. We are, however, assured by exact observations extending back to three-quarters of a century ago, that the mean position of its limits and range have not been altered.

CHAPTER XX.

The Pacific and Indian Oceans similarly described as regions traversed by our Ocean Railways, with a general reference and conclusion.

We have thus far confined our observations to the physical geography of that portion of our globe over which our Ocean Railways system was at first established. It would be as interesting, did our space permit, to extend them equally to the other oceans and seas which are now spanned by it. Some reference, however concise, must be made to these latter regions, where similar causes are producing similar results to those included in our description of the origin of the Gulf Stream.

In the Indian Ocean, for example, we are naturally led to look for warm currents, carrying off from it volumes of heated waters, exceeding many times in quantity those which are discharged from the heated tropical fountains of the great river of the North Atlantic. In fact, the waters of the former ocean are hotter than those of the Caribbean Sea, and the evaporation forces at work there are much greater, for while the Atlantic is open at the north, the Indian Ocean is bounded in that direction by tropical countries.

One of the currents in the Indian Ocean makes its escape through the Straits of Malacca, and after being joined by others from the Japan and China Seas, flows into the Pacific between the Philippine Islands and the shores of Asia. It then attempts, like the Gulf Stream, the great circle route towards the north-west coast of America. Between the physical features of this current, as Maury remarks, and the Gulf Stream there are several interesting points of resemblance.

Sumatra and Malacca, for example, correspond with Florida and Cuba, Borneo to the Bahamas, with the old Providence Channel and Florida Pass to the west. The coast of China, again, answers to those of the United States, the Philippines to the Bermudas, and the Japanese islands to Newfoundland.

As in the case of the Gulf Stream, so also in that of this river in the Pacific and Indian Oceans there is a counter current of cold water flowing from the Sea of Okotsk between it and the shore. The climates, therefore, of the Asiatic coast along which it passes correspond with those of North America along which, as has been stated, the cold current from the Polar basin through the Davis Strait flows, while those of British Columbia and Vancouver's Island are thus also rendered duplicates of those of Western Europe and the British Islands. The climate of Upper California, from the same causes, resembles that of Spain; and the sandy plains and rainless region of Lower California remind one of the desert regions of Africa in the same parallels of latitude. The region of this warm current of the Pacific with its counter cold current, like that of the Gulf Stream and its correlative Arctic current, is marked by mists and fogs. In fact, that of the Aleutian Islands is almost as much renowned for these atmospheric conditions as is that of the Banks of Newfoundland.

Although the "streak" of this current of cold water along the eastern coast of Asia, like its fellow current in the Atlantic, is not at all times strong enough to affect the course of navigation, it is, like the latter, the nursery of fisheries equally valuable, especially off Japan, to those of Newfoundland.

There are, however, amongst others, the following contrasts between the North Atlantic and North Pacific Oceans with respect to the currents named. For example, while a surface current flows north through Behring's Strait into the Arctic Sea, a similar current flows south from it through Davis Strait into the Atlantic. The former strait is too narrow to admit of strong currents flowing north through it, such as that which is known to flow north under the surface current of the latter, and which is so strong and voluminous that Arctic voyagers have described immense icebergs "ripping and tearing their way with terrific force and violence through the surface ice, or against a surface current, on their way to the Polar basin."

There is another remarkable current of warm water from the Indian Ocean, which flows from the south—midway between Africa and Australia—and which appears to lose itself in a kind of Sargasso Sea, thinly strewn with patches of seaweed. On either side of it there is an ice-bearing current flowing up from the Antarctic regions, bringing supplies of cold water to modify the climates and restore the aqueous equilibrium in the Southern hemisphere. The current which flows up west of this weedy sea is the greatest ice-bearer, and its bergs are occasionally encountered by vessels bound to Australia as far north as the parallel of 40° south.

Another current which flows east of Cape Horn into the Atlantic from the Antarctic region, sometimes conveys its icebergs as far north as the thirty-seventh parallel of south latitude, and therefore much nearer than the Gulf Stream allows those from the Arctic Ocean to approach the Equator.

The currents of the Pacific are as yet but little understood. Amongst them is the Humboldt current of Peru, which is felt as far as the Equator, mitigating the rainless climate of that country, and though torrid as to latitude, giving it that of the most favoured of the temperate zone. A branch of this Antarctic current in passing the Gallipagos Islands, situated nearly on the Equator, is a hitherto undeveloped nursery of most valuable fisheries.

Between Humboldt's current and the great equatorial outflow of waters there is a vast area in the southern Pacific which has been marked by Maury as a "desolate region." In the days of sailing ships it was seldom enlivened by the presence of man, for neither the industrial pursuits of the sea nor the highways of commerce led him into or across it. All vessels, however, now pass over it, and in the logs of some of them this ocean desert is described as being almost devoid both in sea and air of the signs of life.

In the wide expanse of the South Pacific, sea-birds will often follow and keep in company with a vessel through storm and calm for weeks together. Those of them, however, which join a ship after she clears Australia will, it is said, follow her to this desolate region and then disappear. Even the chirp of the stormy petrel is never heard here, and the waters of the sea itself are said to be singularly barren of "moving creatures that have life."

There are also many other currents in the Pacific about the Equator of which nothing satisfactory is as yet known. In the region of the monsoons mere surface currents caused by their action prevail during their continuance. Experiments in deep-sea soundings have also brought to light the existence of submarine currents. In one instance a block of wood was loaded to sinking and let down by a fishing-line to the depth of from 100 to 500 fathoms. A small barrel as a float was then attached to keep the block from sinking, and the whole let go by the experimenters. To use their own expression, "it was wonderful to see this *barrega* move off against wind and sea and surface current at the rate of sometimes a knot, and at others of a knot and three-quarters an hour." The men in the boat from which it had been launched could not repress exclamations of surprise, for it really appeared to them as if some monster of the deep had hold of the weight below and was walking off with it. There is, as we have already stated, a surface current flowing south through the Davis Straits into the Atlantic. Beneath it there is an under-current flowing north into the Arctic Sea; for navigators tell us of immense icebergs being rapidly drifted by it in that direction, and not only against the surface current, but also through the fields of ice which it was floating south. The captain of a Dundee whaler, in his narrative of a voyage to these straits, thus refers to such an incident:

"It was awful to behold the immense bergs working their way to the north-east from us, and not one drop of water to be seen; they were working themselves right through the middle of the ice. . . . About 3 p.m. the iceberg came into contact with our floe, and in less than a minute it broke the ice, and shivered the floe for several miles with a noise like the simultaneous explosion of a hundred pieces of ordnance."

The origin and primary causes of these currents are heat, radiation, evaporation, and precipitation, together with the secretion of solid matter by sea-fish for their structures. These agents, by their constant action, make the waters of the ocean salter, and consequently heavier in one part of it than in another. By the action of a well-known law affecting the motion of fluids, this disturbance of their equilibrium by a change in their specific gravity is restored by these currents In illustration of this, we can only here refer to a few facts relative to the action of the latter in producing them.

In the trade-wind region of the Atlantic, the evaporation is supposed to be about half an inch of water daily, or about fifteen feet in depth annually. As this region covers a superficial area of three millions of square miles, the immense amount of salts it leaves behind may easily be imagined. It has been calculated that its mass would cover a superficial area equal to that of the British Islands to a depth of fourteen feet!

Take again the Indian and Pacific Oceans as one sheet of water, with an area equal in extent to that of the whole surface of the earth, upon which 186,240 cubic miles of rain falls annually. Now, not less than three-fourths of the vapour which makes this rain came from these oceans, and if we, therefore, suppose that only half of it falls back again daily into them, and that at least as much is taken up at the same time as vapour, we have 250 cubic miles of water extracted from, and an equal quantity returned to them every twenty-four hours.

In the former case, that of the evaporation over the belt of the Atlantic trade-winds, we have as one consequence the Gulf Stream; and as regards the Pacific and Indian Oceans, what might naturally be expected—a system of currents and counter currents most complicated, and in some cases apparently most uncertain. We may, therefore, lay it down as a scientific fact that all the currents of the ocean owe their origin to difference of specific gravity, however caused, between sea-water at one place and sea-water at another, the heavier going towards the lighter, and vice versâ. And we may further lay it down as the law of circulation in the sea that every one of its currents has its counter current. If it were not so, wherever one current is found carrying off water from this or that part of the sea, some other current must convey an equal volume of water to the same part, else the former would cease to flow after a time from want of a supply to feed it.

We have thus glanced at a few of the wonders of the regions traversed by our ocean railways, in order to remove from them that gloominess of aspect with which they are generally regarded. We can no longer, in view of the part they thus play in the great economy of our planet, regard these regions merely as "a waste of waters." The land part of our globe would be an uninhabitable desert without the moisture they supply, and the softening and equalising effects they have upon its climates. In this connection the atmosphere, which has been aptly described as "a spherical shell surrounding our planet," plays an important part, for when in motion its force is often such as to level forests and stately buildings, or to raise the waters of the ocean into mountain ridges. In its gentler moods it holds suspended in cisterns of clouds the vapours it draws up from the sea, and throws them down again as rain or dew with unerring precision when and wherever they are required. These laws, put in force by the Creator when He laid the foundations of the earth, are but syllables in the great handbook of Nature which only by joining together can the voyager on the ocean as well as the philosopher on the land read aright as they see it spread out before them.

We have also learned that the area of waters which five centuries ago presented such a formidable barrier to the progress and intercourse of mankind have now become, by the "figuration of Arte itselfe," the most important highway of communication between the most distant nations of the globe.

This world-wide rapid and regular intercommunication, as the following comparative statistics demonstrate, has been largely consequent upon the development of steam during the last fifty years as a propelling power for ocean-going vessels. This development practically dates from 1840, when the Cunard Company, under contract with our Government, commenced its Transatlantic mail service.

The total registered tonnage that year of the British mercantile navy was 3,311,528 tons, comprising 2,648,480 tons of sailing and 663,480 tons of steam vessels. Fifty years later, in 1889, the relative proportions of these classes out of a total registered tonnage* of 6,700,615 tons was, sailing ships 2,584,120 tons, as compared with 4,116,495 tons of steam vessels. These figures, however, do not represent the actual extent to which during this period steam has taken the place of "wind" as a motive power in our over-sea trade, because from her more certain and rapid progress a steamship can transport double the amount of freight between two given ports than a sailing vessel ordinarily can. When, therefore, the enormous increase of our over-sea trade is conceived, we may fairly conclude that if it had depended solely upon sailing ships for transport, double the tonnage given for steamers in 1889 would have been required to that of sailing ships in order to meet its requirements.

A passing glance at the progress made in substituting steam for "wind" by the leading foreign Powers shows that France, which had a steam tonnage of but 9,536 tons in 1840, increased it to one of 509,801 tons in 1888. The German Empire, though late in the field, had a steam tonnage in 1880 of 215,758 tons, but has since then rapidly increased it to 502,579. Both these Powers as well as others are, however, indebted to British shipbuilding and engineering skill, between 1858 and 1889, for no less than 1,674,400 of their steam tonnage. All of them having learned the art from us have begun to build for themselves, and have, in the case of France and Germany, turned out some magnificent and powerful steamers, as their Atlantic records show. But they are still a long way behind us in the race, for out of 8,634 sea-going steamers afloat, having a gross tonnage of 10,898,540 tons, Great Britain owned, in 1890, 6,403 steamers with a gross tonnage of 8,235,854 tons, against their 2,131 steamers measuring 2,662,686 tons!

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* The gross tonnage was then 8,235,854 tons.

And this superiority also appears in connection with entries inwards and outwards of vessels at the ports of the United Kingdom in 1889, when, out of a total tonnage of 58,764,200 tons thus entered, 47,020,297 tons, or eighty per cent., were British ships.

The value and importance of our ocean railways may also be illustrated by a reference to the growth of British over-sea trade during the last fifty years.

In 1839 the imports from and exports to foreign countries and British possessions amounted together to £50,061,737. The imports and exports to the United States in the above total amount were £7,585,760, and to our possessions £13,689,267.

The total export and import over-sea trade of the United Kingdom in 1889 amounted to £744,554,982, divided as follows: Foreign countries, £550,931,448; British possessions, £191,986,002; not designated, but included under Parcel Post, £1,667,522.

In a previous chapter a résumé was given of British trade with the far East and Australia. The following, so far as North America is concerned, is here added with reference to its extent with the West.

In 1889 the total exports and imports with the United

States included in the foregoing statement of the trade with foreign countries amounted to £139,023,390, of which £131,340,409, chiefly carried by steamers, came from their Atlantic ports, and £7,682,981, chiefly by sailing ships, came from their Pacific ports.

The trade with British North America included above in that of British possessions, amounted to £20,312,039, nearly all of which, excepting lumber, may be taken as having been carried by steamers.

Our land railways at first carried goods and passengers by all their trains. As traffic increased, "ordinary" and "express" trains were run for the accommodation of the latter, and special trains were established for freight of various kinds. Our ocean railways were, as we have seen, originally intended for the conveyance of mails, specie, and passengers. Freight was carried only in limited quantities, and of only such classes of goods as could bear the comparatively high rates of freight demanded for their transport. In course of time as the over-sea trade increased, a division of traffic similar to that on our land lines took place, as is illustrated in the thirty regular steam lines between Europe and New York. Of these eight are expressly employed in the conveyance of mails, specie, passengers, and what in America is known as express freight, four lines carry both ordinary freight and passengers, and six lines freight only. The same subdivision obtains the world over.

And here we must for the present take leave of our readers with regret, as many things remain unwritten on other points of the interesting subject to which we have called their attention. Sufficient, however, has been brought before them to warrant the conclusion that the sea has been one of the physical influences which has raised the character of the British race to